July 1996

Mobile Radio Technology

Technical information for paging, SMR and private wireless networks.

Boston tunnel project

- Flex paging
- RF isolation
- Product/Logo directory

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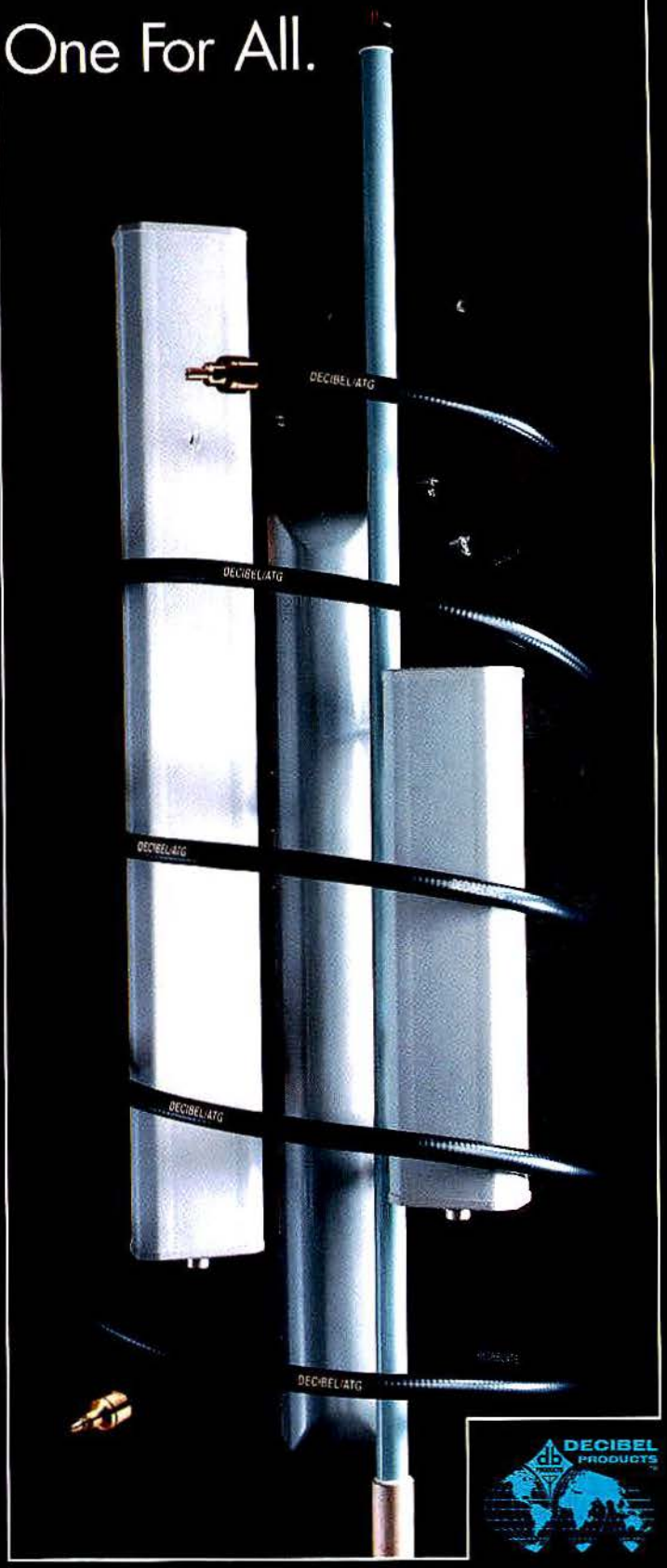

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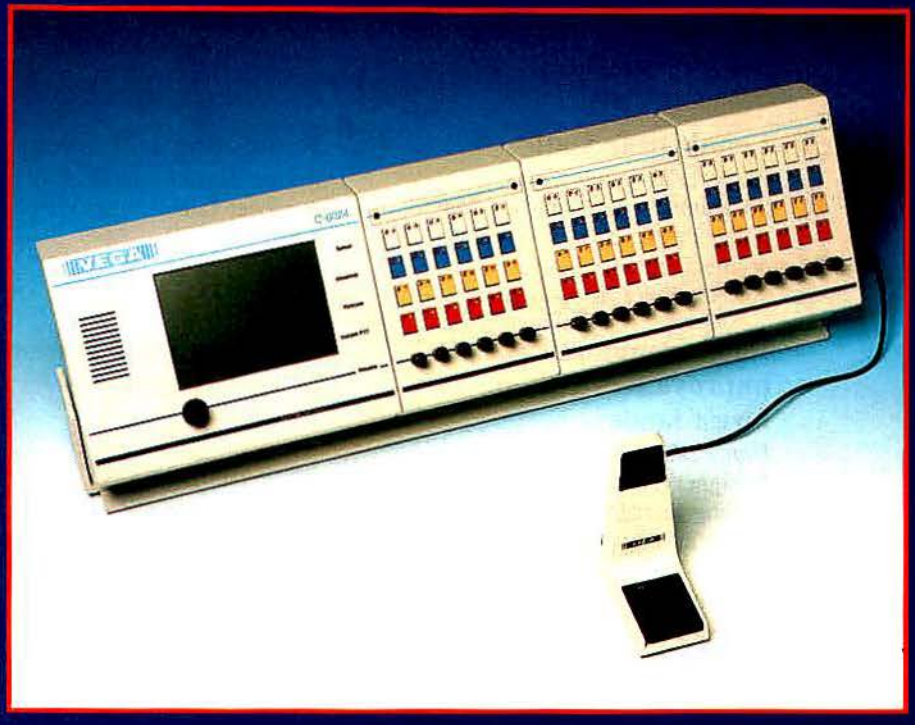

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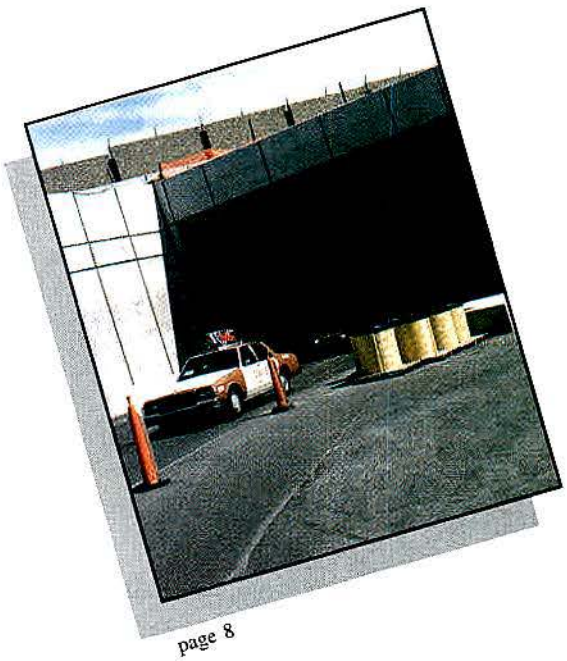

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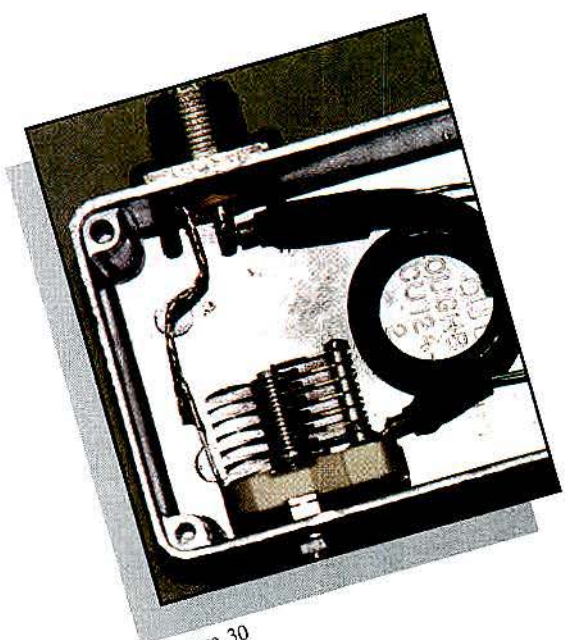

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features

On the cover: Cabling installation during construction of the Ted Williams Tunnel, Boston. See article on page 8. *Photo by Shelton Photography, supplied courtesy of Burndy Electrical, Manchester, NH.*

departments

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Technical report to help system designers and frequency coordinators

Have you heard that there are two new technologies moving into the 800MHz public safety radio frequency bands? One is frequency-division multiple access (FDMA), and the other is time-division multiple access (TDMA). A way of looking at it is that one uses several narrowband digital channels, and the other uses one wideband digital channel, in a given bandwidth.

The Associated Public-Safety Communications Officials (APCO), which serves as a trade association and a frequency coordinating company for public safety agencies, has been working in conjunction with the Telecommunications Industry Association (TIA) to develop a public safety digital radio standard. As it became apparent that more than one type of digital radio system would be occupying public safety frequencies, TIA began to develop methods to assist in the frequency assignment, design and operation of both types of system so that each one could avoid interfering with the reception of the other.

Spectrum refarming

Then, along came spectrum refarming for the private land mobile radio frequencies below 512MHz, affecting both public safety and non-public safety systems. Spectrum refarming means revised regulations that modify existing technical standards and operating conditions. The idea is to make it possible for increasing numbers of transmitters to be used without creating too much interference. The result is going to be a mixture of modulation technologies and bandwidths on frequencies that used to be occupied on 25kHz or 30kHz channel centers by frequency-modulated (FM) radio. What once was fairly simple now becomes quite complex.

The Industrial Telecommunications Association, among other trade associations and frequency coordinating companies, realized that new guidelines would be required to assign frequencies among various narrowband and wideband digital and analog facilities. When ITA started talking with TIA about such guidelines, TIA's years of experience in working on the public safety digital radio standard were applied and expanded in helping to create a blueprint for coordinating frequencies in the spectrum refarming environment.

Joint TIA-IEEE project

Working together with the Institute of Electrical and Electronics Engineers' (IEEE) Vehicular Technology Society (VTS) propagation committee, among other participants, the TIA's working group on technology compatibility (designated WG 8.8) set about to create a document that frequency coordinators, system designers and manufacturers could use to place new radio communications systems within the radio spectrum and within geographic areas for the best results. Actually, the document will serve as a basis for writing computer software to automate the processing of license applications using system specifications and terrain data in ways that pre-computer methods could not.

Are you ready for the name of the document? "A Report on Technology-independent Methodology for the Modeling, Simulation and Empirical Verification of Wireless Communications System Performance in Noise- and Interference-limited Systems Operating on Frequencies Between 30 and 1,500 MHz." Whew.

"For decades, the wireless industry has been in need of an objective, accurate means of assuring wireless systems are properly designed, tested and validated," said Gregory M. Stone, Ph.D. E.E., a co-chairman of WG 8.8 and chairman of the IEEE VTS propagation committee. "In addition, there has been a critical need for a fair and objective empirical method of resolving interference disputes. The efforts of the TIA and IEEE have appeared to pay off with the newly released report."

Reactions

ITA seems to be pleased with the document. "It will lead to better use of the spectrum compared to previous engineering methods," said Sharpe Smith, ITA manager of communications and public affairs. "We support the development of these guidelines. We not only support, but we have proactively attempted to bring the process into the refarming realm. We're not just giving it lip service, we're showing up at the meetings, and we're providing input. We think it important to the success of the post-refarming environment to have these guidelines."

APCO's executive director Ronnie Rand said that although it appears that some of the document may be complex for frequency advisers, "It appears to be a useful document. We view it as something that can be helpful in the coordination process. It is obvious that the people who worked on it took their task very seriously." Rand also said that the suggestion that perhaps the FCC should publish the document and ask for public comment has been discussed.

Stone said that the joint TIA-IEEE effort enjoyed widespread land mobile industry and user community support. In addition to contributions made by APCO and ITA, he cited Ericsson, Motorola and the U.S. Immigration and Naturalization Service (INS). An acknowledgment published in the report says that the genesis of the document is the brainchild of Carl B. "Bernie" Olson, director of resource development engineering for Motorola's National Engineering Services. It credits the following with substantive contributions: Harry Anderson, Ph.D., EDX Engineering; Dominic Acuri, Ericsson; John Oblak, E.F. Johnson; Brad Hiben, Tom Rubinstein, Casey Hill and Al Wieczorek, Motorola; and Judith F. Furie, INS. The INS provided additional staff and resources to produce the document.

Results

Congress and the FCC pass their laws and regulations. Manufacturers create their equipment specifications. Operators for proposed communications systems design their facilities. Frequency coordination companies recommend or select radio channel assignments. Along the way, engineers and technicians have the responsibility to make communications systems function within the framework created by regulation, frequency coordination and available equipment.

We hope the TIA document will result in software development, frequency coordination procedures and regulatory policies that will help spectrum refarming to provide the improved services and expansion of the number of users that are expected. Our congratulations to the participants who drafted the document.

—Don Bishop

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11–13—Communications Expo/Show of the Americas, Miami, FL. Contact: 305-229-9992.

14–17—Forestry-Conservation Communications Association annual conference, Howard Johnson Plaza Hotel, Madison, WI. Contact: Tom Tuttle, 608-246-7998.

August

11–15—International Association of Public-Safety Communications Officials (APCO) National Conference, San Antonio, TX. Contact: 800-949-2726.

September

19–21—Personal Communications Showcase, sponsored by the Personal Communications Industry Association, Moscone Convention Center, San Francisco. Contact: 800-326-8638.

October

30–Nov. 1—WirelessWorld Conference and Exposition, sponsored by *Cellular Business* and *Mobile Radio Technology* magazines, Orange County Convention/Civic Center, Orlando, FL. Contact: Susan Link, 913-967-1969.

November

22—Radio Club of America, Communications Symposium, 87th Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Ron Formella, 201-652-6811.

18–19—AMTEX, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, Intercontinental Hotel, Miami. Contact: 202-331-7773.

1997

March

3–5—Wireless, sponsored by the Cellular Telecommunications Industry Association, Moscone Convention Center, San Francisco. Contact: 202-785-0081.

23–27—Energy Telecommunications and Electrical Association, New Orleans Convention Center, New Orleans. Contact: 214-235-0655.

April

22–24—International Wireless Communications Expo, co-sponsored by *Mobile Radio Technology*, Las Vegas Sands Convention Center, Las Vegas. Contact: 800-828-0420.

May

5–7—Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Hyatt Regency at Civic Plaza, Phoenix, AZ. Contact: Wendy Rochelle, 908-562-3870; Fax 908-981-1769.

June

2–5—Supercomm, sponsored by USTA and TIA, New Orleans Convention Center, New Orleans. Contact: 202-326-7300.

16–20—UTC National Conference & Exhibition, sponsored by UTC, The Telecommunications Association, Oregon Convention Center and Red Lion Lloyd, Holiday Inn, and Travelodge Hotels, Portland, OR. Contact: 202-872-0030.

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Boston breaks new ground on tunnel, radio communications

A sophisticated antenna system extends 31 channels of trunked and conventional radio communications below ground to serve public safety requirements within a 1.67-mile long tunnel beneath the Boston Inner Harbor.

By Dr. Peter Mailandt

The city of Boston has a history of implementing technological breakthroughs for its public safety departments. In 1852, the city broke new ground in the use of technology when the world's first electronically transmitted alarm was sent to the fire department's dispatch center. More than 70 years later, the United States' first two-way public safety radio system between a fire department dispatch center and fire boats patrolling Boston Harbor was functional in 1923. Moving forward in time another 72 years, Boston became the site of a more advanced breakthrough in radio communications.

In late 1995, highway authorities opened a new tunnel under the Boston Inner Harbor. The new tunnel, christened the Ted Williams Tunnel in honor of the former Red Sox star and member of the Baseball Hall of Fame, connects the Greater Boston Area and Logan International Airport. Because the tunnel has yet to be opened to private-sector traffic, the vehicles traveling its 1.67-mile length are used by public safety or service agencies such as the local, county and state police departments, the Boston Fire Department, airport authorities, the Massachusetts Highway Department and the Massachusetts Turnpike Authority. According to highway department officials' projections, more than 18,000 vehicles will pass through the tunnel each day once the tunnel is open to the private sector.

Fleet dispatch such as taxi cab and other mobile users are able to maintain radio contact with base throughout the entire length of the 1.67-mile Ted Williams Tunnel. A 31-channel "leaky" cable antenna provides reception under the Boston Inner Harbor.

For every public safety, transit department or airport authority vehicle that travels the tunnel, the need for constant contact with its dispatch center is crucial. Whether it's police squad cars or airport maintenance, each trip through the Ted Williams Tunnel could have an effect on the community's well being.

However, the walls of the tunnel pose a man-made barrier to radio frequency (RF) signals that carry radio communications. To work around this barrier, highway planners and officials needed a single radio antenna system that could support 31 channels simultaneously—a system the world never had seen before.

Boston city officials conducted a thorough site survey and presented specifications and requests for proposals to leading wireless communications equipment manufacturers and systems integrators, including our company. After the specs were reviewed, responding companies produced proposed block diagrams of their recommended antenna systems. Based on our technical response and willingness to custom-design necessary components for the unique assembly, Boston

Mailandt is president, Decibel Products Division of Allen Telecom Group, Dallas.

city and Massachusetts highway officials awarded the job to us.

As if that weren't enough

The degree of difficulty didn't peak with creating an antenna system unique to the world of wireless communications. In addition to the challenges faced by the application engineering team in terms of delivering radio signals for 31 different channels along the complete expanse of the 1.67-mile tunnel, the Ted Williams Tunnel and the antenna system presented two other obstacles.

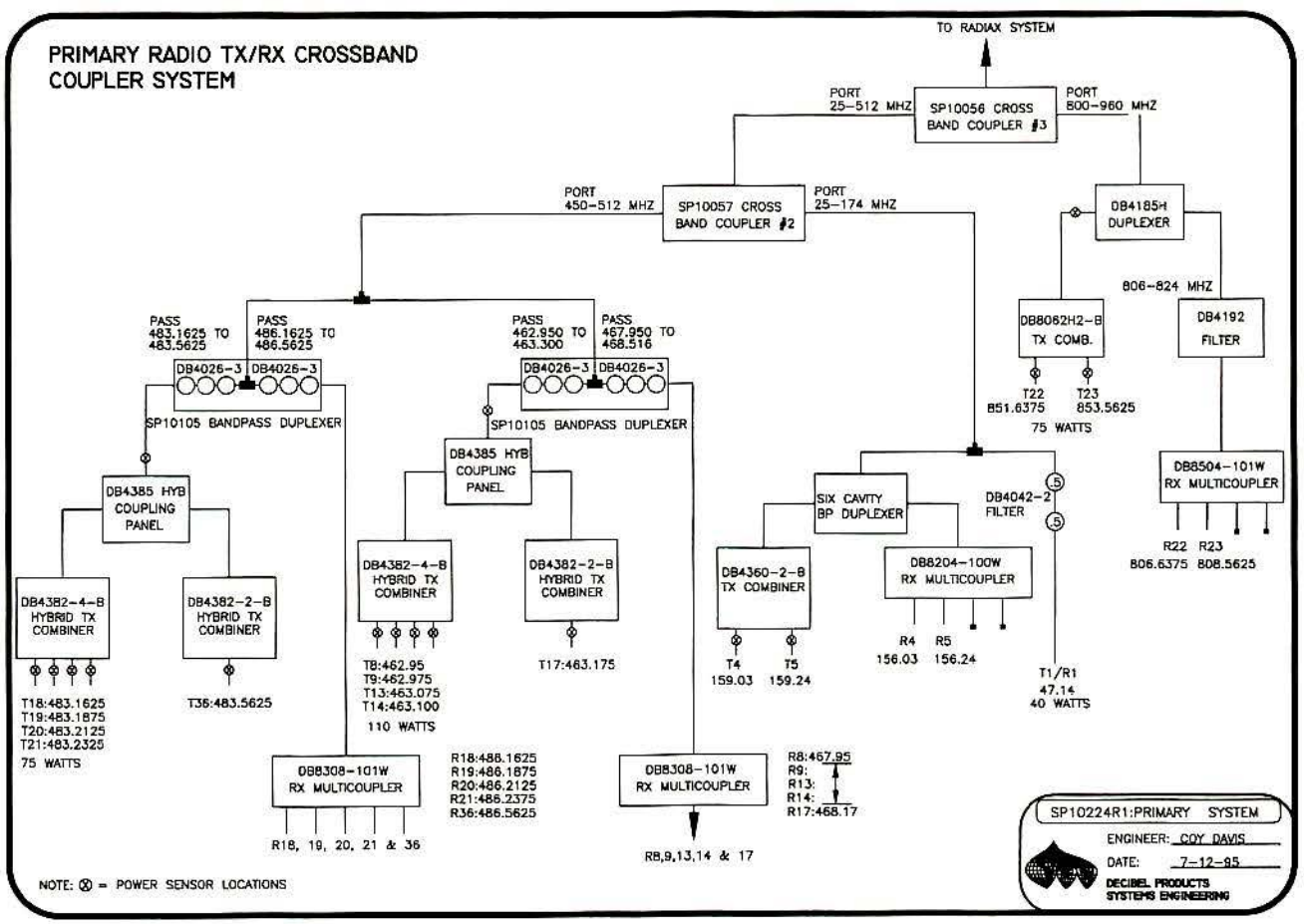
First, there was the physical impediment of the tunnel's walls and the depth at which the tunnel lies on the harbor floor. The antenna system would have to operate through the length of the tunnel with only two viable locations providing access to local donor base stations to install the necessary equipment. Ventilation buildings on the surface at both ends of the tunnel were the installation sites for a variety of combiners, duplexers, multiplexers, phasing equipment and crossband coupler combiner systems.

The installation of the components in the ventilation buildings was only the first step in delivering RF propagation throughout the tunnel. A method of distributing RF signals along the curvature of the tunnels had to be devised. A distributed antenna system—small interior antennas strategically placed throughout a structure—was ruled out because of the sheer number of antennas that would be required. The alternative turned out to be a system of leaky cable running along the roof of the tunnel. Leaky cable is a by-product of conventional coaxial cable with small slits cut though its layers that allow RF signals to seep out in amounts strong enough to cover small areas of square footage. Because the RF signals are distributed at regular intervals, the use of leaky cable precludes the need for additional antennas to be installed throughout the tunnel.

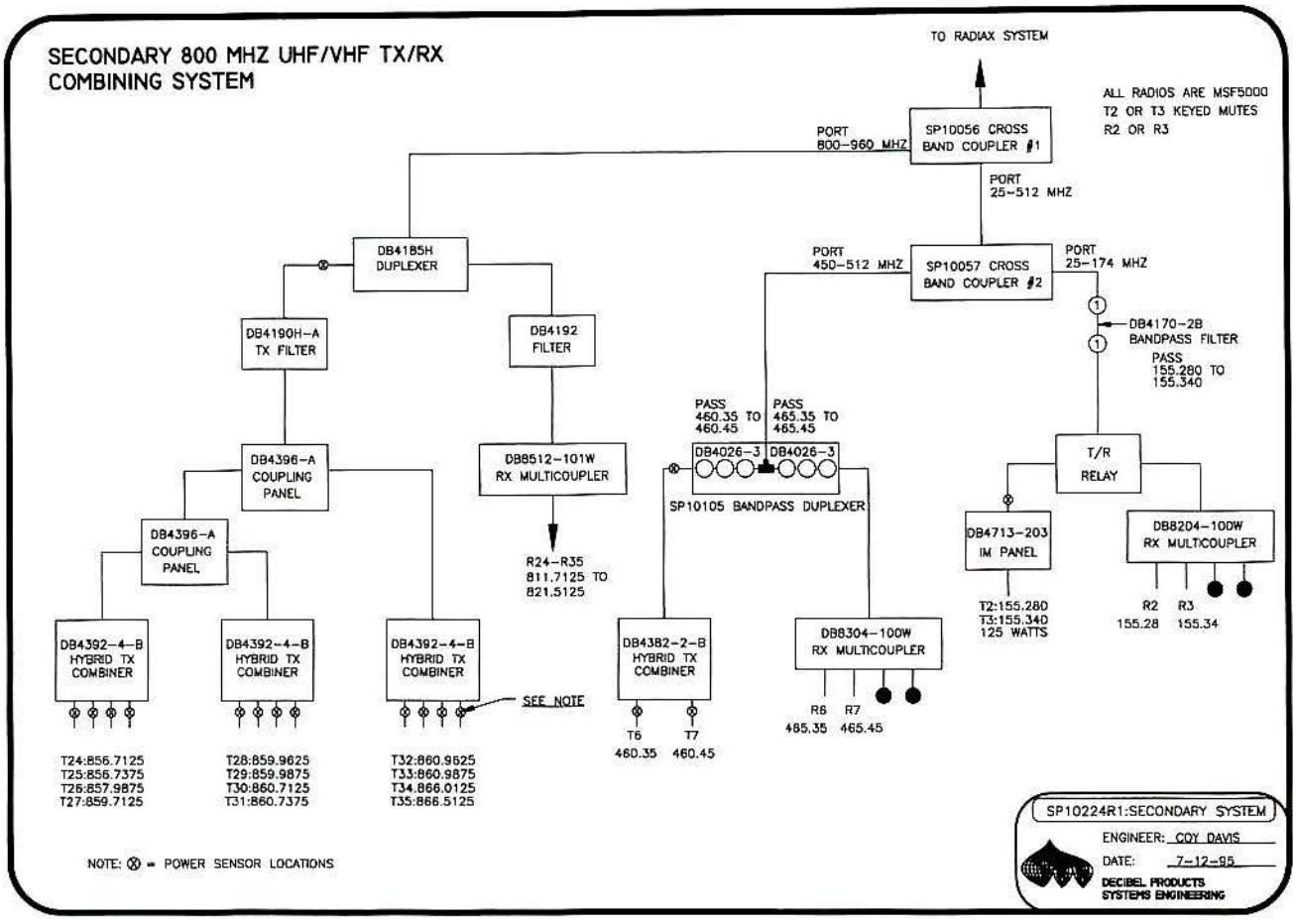
The second, and most difficult, challenge was to create a system that would carry all 31 radio channels necessary for providing wireless communications to the various agencies using the Ted Williams Tunnel. In the Boston area, public safety, highway department and airport agencies use frequencies ranging from 47MHz to 860MHz. Specific frequencies on the antenna system include UHF, VHF and 800MHz trunking systems. To prevent co-channel interference and to attenuate signals between channels, the application engineering team charged with integrating the system used a combination of filtering products and combiners, some of which were custom-designed because of the uniqueness of the project. The same components used to prevent co-channel interference inside the tunnel also eliminate the potential for simulcasts with above-ground systems.

Putting it in perspective

The majority of public safety, airport and transit authority representatives driving through the Ted Williams Tunnel probably are unaware of the historic radio antenna system bringing them crucial wireless communications. However, those who participated in the design and installation of the antenna system—as well as department officials in charge of telecommunications for the agencies relying on the tunnel—are well aware of



This is the diagram for the primary radio transmit-and-receive crossband coupler system submitted in response to Boston city officials' specifications and request for proposals.



This is the diagram for the secondary 800MHz UHF/VHF transmit-and-receive combining system for the Ted Williams Tunnel in Boston as submitted with a proposal to city officials.

the breakthrough accomplished with the revolutionary system.

A comparison with radio antenna systems functioning in two of the world's more renowned tunnels puts the feat of the application engineers into a concise context. For example, the antenna system operating in the Washington Tunnel, part of the Washington, DC, subway system, supports only seven radio channels, or less than 25% of the channels carried though the Ted Williams Tunnel. In what is arguably the world's most famous tunnel, the Chunnel connecting England and France, an antenna system supports 15 radio channels.

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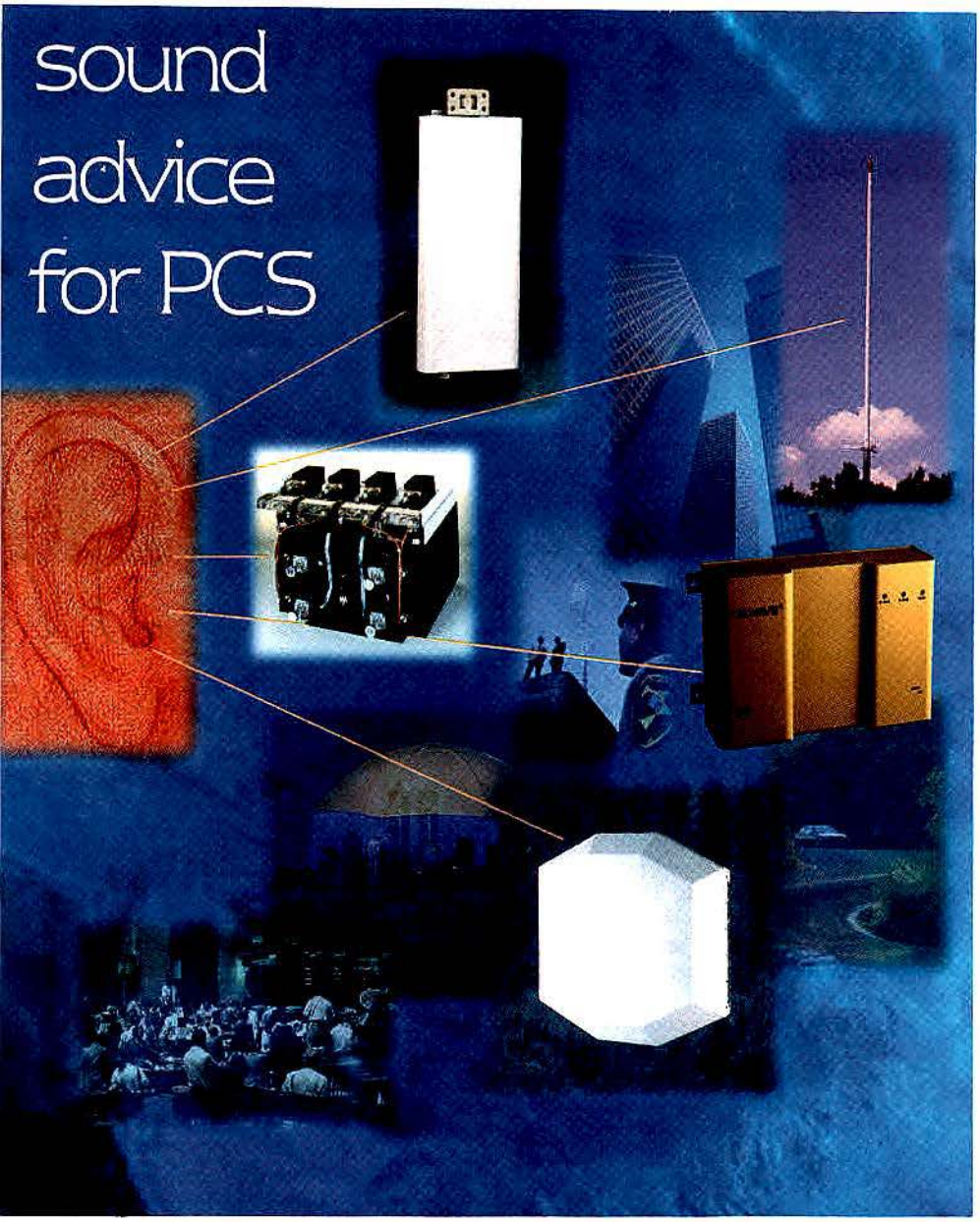

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System integration of the Flex paging protocol

Part 2—System design recommendations.

Integration of the Flex paging protocol onto existing paging channels will present system design challenges for systems not yet optimized for the higher data rate of 6,400 bits-per-second (bps), but which are slated for operation at that rate. The most significant constraint facing designers is control of coverage overlap areas. However, until such time that the system may be optimized for 6,400bps, carriers will enjoy several benefits in paging with 3200 4-level Flex over 2400 POCSAG. The main benefits include relaxation of the coverage overlap increase in throughput. In many cases, there is good reason to introduce the Flex paging protocol, at the operator's earliest convenience, onto paging channels currently performing, even marginally, at 2400 POCSAG.

By Lee I. Williams

Meeting the simulcast delay spread (SDS) constraint for 6400 Flex will require a certain amount of system design review. Yet, a system design review is long overdue for many paging systems, regardless of plans to introduce Flex. Periodic system evaluation should be an intrinsic part of a carrier's strategic plan to provide adequate service. This implies proactive—rather than reactive—system planning, design, monitoring and maintenance. A recommended plan for evaluating system performance and implementing design changes follows, with individual parts presented in a step-by-step order.

Step One — *System performance check:* Use all available information for an indication of overall system performance and to reveal localized pockets of less-than-adequate service. Trouble-report databases, bit-error-rate mapping studies and field technicians all are good sources of information. Pay particular attention to areas that exhibit poor or marginal POCSAG 2400 reception, because these areas will provide a good starting place for evaluating Flex performance. Launch a periodic system monitoring and evaluation program, if one does not already exist.

Step Two — *Configuration check:* Check and re-check all configuration operating characteristics and settings throughout all components of the paging signal flow chain. A systematic approach starts at the terminal and ends at the paging transmitter power amplifiers. Of particular interest are terminal software patches, controller software versions, exciter software versions, equalization delay settings, deviation settings and rise-time settings. If the system is composed of multiple frequencies, be sure the channel frequencies are programmed properly into the controllers and the exciters. A transmitter keying on one channel with another channel's data destroys reception for a large area of coverage. Configuration log books at each site are particularly helpful in determining and maintaining system status.

Table 1—10 Steps for evaluating system performance and implementing design changes.

1. System performance check
2. Configuration check
3. Transmission site check
4. System performance baseline
5. Configuration recheck
6. Simulcast testing
7. Propagation and coverage analysis
8. Implementation of system design changes
9. System baseline
10. Continued system monitoring

Step Three — *Transmission site check:* Each transmitter site should be checked on a routine basis for proper installation and operation. Every aspect and detail of physical installation should be inspected, from cabinet grounding to proper antenna installation. It is advisable to draft a site-visit checklist and to require its completion upon each visit.

Williams is senior systems engineer at Glenayre Electronics, Quincy, IL.

Flex, a Motorola trademark, is short for flexible, wide-area, synchronous paging protocol.

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Step Four — *System performance baseline:* Once configuration and hardware checks are completed, a thorough system baseline should be documented to pinpoint trouble areas for simulcast testing and to serve as a reference point for comparing performance results after system changes have been implemented. Use a variety of analysis tools for characterizing the system (e.g., bit-error-rate mapping, received signal strength indication [RSSI] mapping and paging probability counts), and thoroughly document the testing process so that tests may be duplicated as closely as possible after implementing the system design changes.

Step Five — *Configuration recheck:* If any system changes or component replacements have been made during or after the system performance baseline, then verify all affected components for proper configuration.

Step Six — *Simulcast testing:* Based on the system performance baseline results, localized performance problem areas that have adequate signal strength should be tested to find out why a problem exists. Usually, this is an indication of an SDS problem. A good initial test is to take page probability counts in areas with marginal POCSAG 2400 performance. First, look for page count improvements at 3200 4-level Flex compared with POCSAG 2400. Next, compare 3200 4-level Flex with 6400 Flex for degradation at the higher data rate. If both of these conditions hold true, then the probable cause is that the SDS constraint has been exceeded. The degree of paging improvement between 6400 Flex and POCSAG 2400 and between POCSAG 2400 and 3200 4-level Flex indicates the severity of the delay spread.

Presuming that the reception problem is SDS-related, it may be possible to determine which distant sites are causing the problem by keying up all transmitters in the area one at a time while halting paging traffic and taking a relative measurement of the received signal strength of each transmitter. If it is found that one or more distant sites (i.e., farther than 14 miles away from nearest site) is being received with signal strength within 10dB of the nearest site, then it is likely that that site is contributing to the SDS problem. After establishing which sites are likely contributors, they could be taken off-line so a page count test can be rerun to compare results with the original page count test for signs of improvement. This process may identify which distant transmitters are affecting the test area. However, it is important to note that a correlation may only be drawn between "culprit" distant sites and the particular test area where the measurements have been taken. Therefore, the most efficient step is to take measurements in as many problem areas as practical and, in that way, identify culprit sites that are creating problems in multiple areas.

Step Seven — *Propagation and coverage analysis:* Based on simulcast and baseline test results, site selection, antenna placement and antenna selection may be simulated for optimizing system design. Whether this analysis is done in-house or contracted out, ensure that the analysis gives consideration to delay-spread issues, and not simply to RSSI level. It is strongly suggested that high-gain, omnidirectional antennas be considered for replacement with lower-gain, downtilt or panel-type antennas. In addition, reconsider whether to use antenna sites on mountains or other high elevations, because they are often found to be major contributors to SDS problems.

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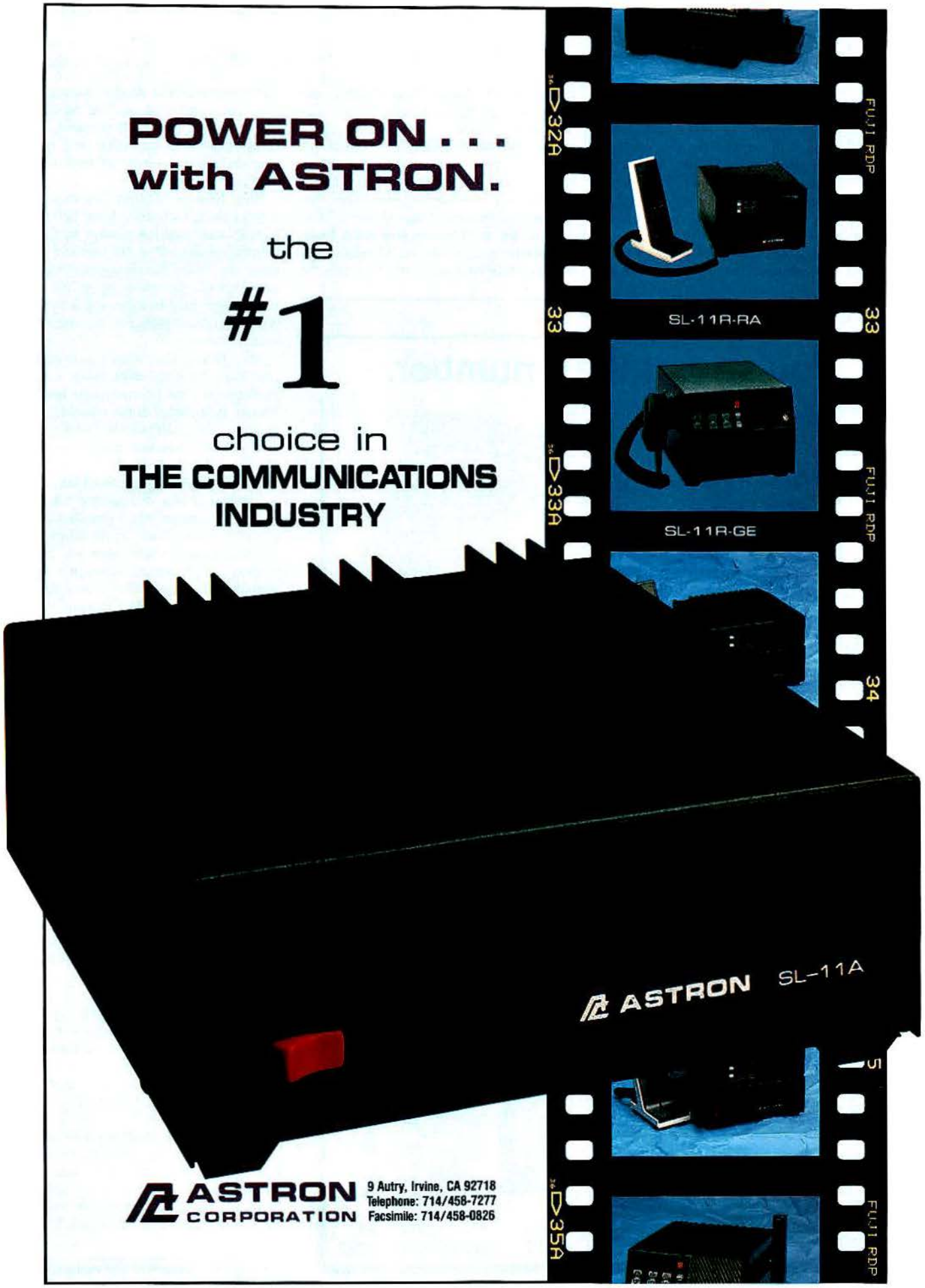

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Note: It is in the carrier's best interest to take an active role in system analysis and design because no other party has a more vested interest in the system's performance nor a more intimate knowledge of the customer base for which service is being provided.

Step Eight — *Implementation of system design changes:* Sectionalize planned system design changes both geographically and conceptually. That is, categorize and confine design changes by geographic conditions and by the proposed type of solution. Also, instead of sweeping the entire system with broad changes, try less-costly solutions first in small sections of the coverage region. It may be found that taking mountaintop or other high-elevation sites off-line and implementing relatively inexpensive antenna changes will result in an acceptable level of service. Conduct pilot tests in areas with lower use to verify the effectiveness of the design changes to reduce the chance of causing an adverse effect on area paging. If possible, implement changes in steps that may help to characterize the degree of improvement that each provides.

Step Nine — *System baseline:* After system design changes have been completed, once again document the system baseline, using all of the characterization tools available. Building-penetration issues that did not show up in the initial studies now may become apparent. These types of issues probably will need individual attention.

Step Ten — *Continued system monitoring:* Take the time to establish a system performance monitoring schedule, and stick to it. Included in the schedule should be site visits, configuration checks, simulcast tests and baseline tests.

Small deviation offsets for Flex

Whether or not to implement a deviation offset scheme into a paging system is a controversial issue. In my opinion, an offset scheme is advisable because, if properly implemented, deviation offsets would not degrade system performance but would provide the potential to improve it. Furthermore, if zero-beating is considered to be problematic in a particular system, then any offset, even a small one, would be preferable to no offset at all.

An important control feature for system optimization is the ability to switch to deviation offsets on a protocol basis. This feature allows the system to have different deviation offsets programmed for different protocols that have conflicting optimum settings, such as POCSAG and Flex. However, if a deviation offset scheme is to be implemented on a mixed protocol channel, and the offsets cannot be adjusted according to which protocol is in use at any given time, then an offset regimen appropriate for Flex should be enacted. The reason is simply that the POCSAG protocol is tolerant to Flex-type offsets even though they are not the optimum choice for POCSAG, whereas Flex is intolerant to POCSAG-type offsets. A good regimen to try initially would be −30Hz, 0Hz and +30Hz implemented in such a way that the overlap areas experience deviation differentials of 30Hz or 60Hz. (This recommendation is based upon laboratory testing with a static environment.)

Deviation for the majority protocol

From a system optimization viewpoint, it would be preferable to deviate at the recommended levels for each protocol. However, for systems currently unable to adjust deviation to different levels based

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on protocol, it is recommended to set deviation levels to match those that are appropriate for the paging protocol occupying the majority of air time. That is, if the majority of traffic is POCSAG, then set deviation levels to 4,500Hz. It should be mentioned that some national carriers use 4,500Hz deviation exclusively, and other national carriers use 4,800Hz deviation exclusively, with a mixture of protocols on their channels. To date, there has been no reported significant degradation associated with either option. Therefore, unless degradation is experienced by a particular deviation setting, reconfiguring a large system from one deviation setting to the other probably would not be worth the effort.

Conclusion

The Flex protocol is not only an attractive alternative to POCSAG, but to many paging systems with unprecedented growth, it is a necessity for increasing throughput. In the near term, paging systems may require redesigning to provide adequate 6400 Flex performance. However, a key feature of Flex is its ability to perform at any of the programmable Flex speeds. Thus, if the system slated for introduction of Flex protocol is not currently capable of acceptable 6400 performance, then Flex may still be introduced, if only at a slower data rate. System redesign may be accomplished concurrently with Flex migration or at some later date.

There is little doubt that, eventually, all Flex system infrastructure providers will be producing paging equipment capable of deviation and offset changes on a protocol basis, thereby allowing systems to be optimized for more than a single protocol. Although such features are necessary for complete system optimization, the system improvements enjoyed as a consequence may not be readily apparent until such time as the basic system design has been optimized.

The biggest challenge facing the introduction of 6400 Flex is meeting the SDS constraint while at the same time providing adequate signal density to support the increased data rate. In rural and suburban areas, the system may require little or no redesign. However, in the urban or the mountainous environment, a significant amount of redesign effort may be necessary. The system performance that will be achieved will be a function of the effort and expertise invested in the system redesign phase.

Acknowledgments

A special thanks to Jack Gleeson, Subscriber Development Engineering, Motorola, for an unbiased sharing of deviation offset test results and information, and to Michael J. McCabe, Glenayre Electronics, for assistance in a technical review of this article.

Flex integration series

"System Integration of the Flex Paging Protocol."

Part 1—System design constraints, June 1996.

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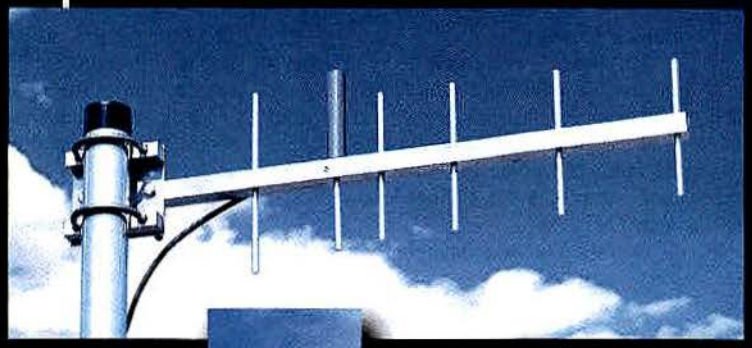

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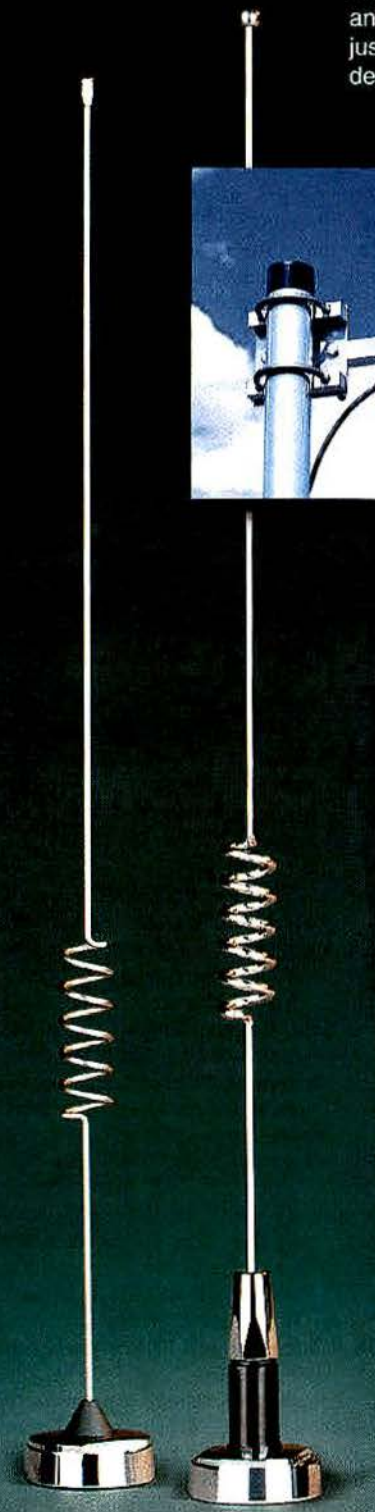

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I can't hear you!

Sometimes a reception problem cannot be traced to RF, electronic or mechanical causes. What's left? 'Know your customer' is good advice. Also, tips for making VSWR measurements with a wattmeter faster and more accurate.

By Walter Rheingans

The first of the month always comes with a groan, followed by a sigh of relief. The groan, I think, is because of our "billing party." The shop staff gets together, closes the prior month's books, then prepares and stuffs bills into envelopes. In one swoop, we are ready for another month, and the customer has a timely statement. I hear that many small shops share the work just like we do.

"My favorite part," said Ruben, "is when all the envelopes are picked up by the mailman, and we can concentrate on the next job."

"Not for me," I said. "My favorite part is to see the whole staff working together on the billing. This really helps you all stay in touch with the customer; sort of the final step in customer service."

"My favorite part," said Jerry, "is that the boss buys lunch and coffee for the day—My favorite part!"

The next day, with all the billing statements in the mail, Ruben began the new month by reviewing the day's job assignments. Privacy Plus, the private investigations company, scheduled a repair for 9 a.m. Ruben assigned that job to Jerry. At 9:11 a.m., the ambulance operator already had an installation job in the work bay on which Karen was starting. Karen also had another install scheduled for the water company. It looked like another good month for the company. It always looks like a good month when business is in the shop from the first day.

"Jerry, front and center," requested Ruben, as Fred, an investigator with Privacy Plus arrived at the shop. "Your nine o'clock is here!"

"Hi, Fred!" welcomed Jerry. "What's the trouble with your radio today?"

"I can't hear the dispatcher, Jerry," said Fred. "I guess I should rephrase that; I hear the radio call come in, but I can't understand what they are saying. Know what I mean?"

"Sort of. You hear them, but you don't," Jerry recapped.

"Yeah, that's it," agreed Fred. "I'll leave the car with you and be back around ten o'clock—Thanks!"

Jerry took the keys, wrote up a job ticket and drove the car into the service bay. The installation for Privacy Plus was unusual in that it was a trunk-mount radio with the control head hidden in the glove box and the speaker under the drivers seat. The mounting configuration had been specified by Fred to allow the vehicle to be used in undercover investigations. It had only been in service for about a month. Fred had a normal dash-mount radio in his previous car. Jerry went right to work, following shop procedure to pull the main radio unit from the trunk. Then he performed a bench test to be sure the radio met the SINAD specs of the manufacturer. This checked out OK, and because the SINAD measurement is a fair test of audio quality, that only left the speaker under the seat to be checked.

"THE BETTER YOU KNOW YOUR CUSTOMER, THE EASIER IT IS TO FIX HIS RADIO COMMUNICATIONS PROBLEM."

"Boy, these hidden installs are a bear to work on," lamented Jerry as he worked under the seat. "You almost have to work by feel, 'cause there's little room to see."

"What are you finding?" called Karen from across the bay where she was struggling with the antenna install on the ambulance.

"Radio checks OK, so the problem must be in the speaker," he replied, still under the seat. "I hear a little rattle sound from the speaker, so I'll put in a new one."

Using the existing mounting, Jerry replaced the speaker with a new one out of inventory.

Fred returned as Jerry finished, signed the job ticket and drove away immediately. Jerry was just putting the job ticket in the "finished" basket, when Fred returned.

"Jerry, come on back up front," requested Ruben. "Fred says he ain't fixed yet!"

"Hi again, Fred," said Jerry. "I told you the unit checked OK, but I thought I heard a rattle in the speaker. I put a new speaker in it."

"Sounds the same to me," Fred said. "I was just telling Ruben the problem wasn't so bad when I had the other radio, but with this one I can't understand the office. Maybe I shouldn't have switched to the trunk-mount undercover radio."

"Fred," Ruben advised, "This undercover radio is top-of-the-line. You can't get better than that. Can you leave it for the morning and let us do a little more checking? Wes will let you take his pickup for the day if you need wheels."

"OK, I'll leave it, and I'll see you about noon."

All the while Jerry and Ruben were struggling with Fred's problems, Karen was having problems of her own. She was now finishing the install on the ambulance. The last thing was the antenna, and she

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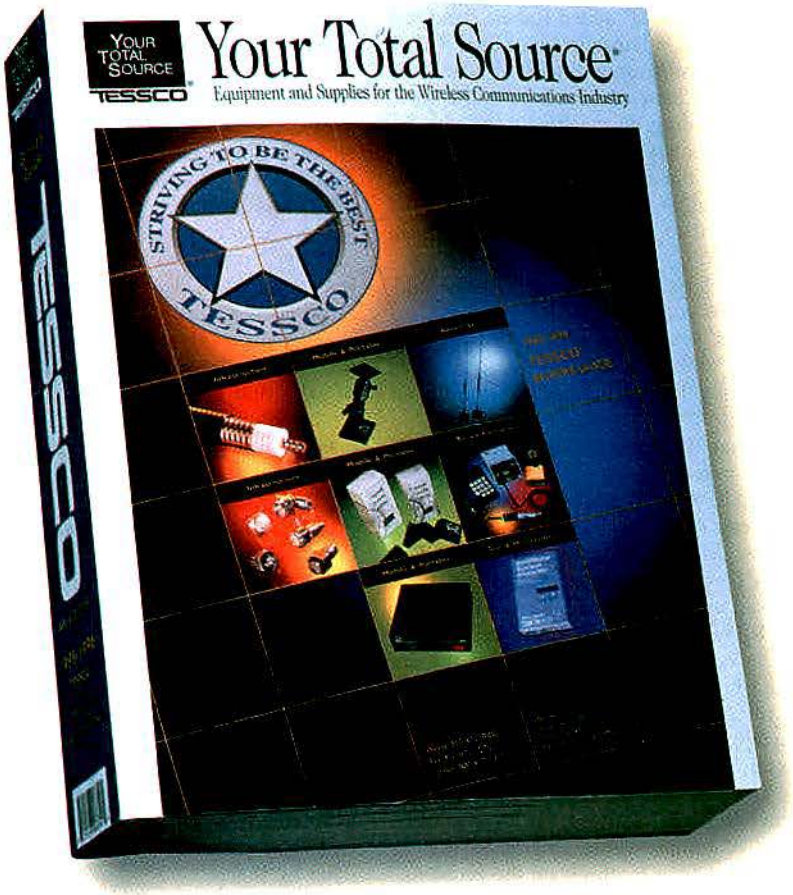

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couldn't get it to work. Karen had installed a self-ground-plane antenna on the fiberglass roof, but it had high VSWR, and the readings jumped around as she tried to measure and adjust the radio and antenna combination. Starting with 25W forward power and 15W reflected power, she would make an adjustment to the antenna, and the wattmeter would read 45W forward and 17W reflected. And so, over and over, adjusting and adjusting, she was getting nowhere. This really was confusing because it was a 40W UHF radio, so she didn't see where the power would jump around from 25W to 45W as the antenna was adjusted.

"Have you all got time to interrupt Fred's problem and give me a hand?" Karen asked, more to everyone within earshot than to anyone in particular.

"Sure," I said.

"Me too," said Jerry.

"I'm all hands," added Ruben, "and just what kind of a hand do you need?"

"I'm dumbfounded with this darned antenna," Karen admitted. "I can't get a straight reading on the Bird wattmeter for love nor money. What bothers me is that as I adjust the antenna, the forward power coming out of the radio jumps around. I can't get it to stay steady so I can finish the install."

"Let's look at your setup," Ruben said. "How are you checking it?"

"I can see the trouble from here," I added, "and it is easy to fix. You have the wrong length jumper cable on your wattmeter."

"What difference does that make?" Karen asked.

"Yeah, what?" echoed Jerry.

"I can explain all about critical length cables," chimed in Ruben. "If the VSWR wasn't very high, you would not have noticed much difference, Karen. But when the VSWR is bad, you know, really high, the insertion of the wattmeter in the antenna line causes an additional mismatch, so to speak, and the readings don't mean anything. It just shows that the VSWR is awful, that's all.

"Get out the file copy of the Bird instruction book," I added. "It'll show you a chart of jumper cable lengths to use for each frequency to eliminate the problem."

"I'm always looking for a jumper, too," Jerry said. "When I'm doing site work, I need a jumper that has type N connectors on it. I put N-adapters on the wattmeter for site work and leave the UHF connectors alone for shop work."

"I'll tell you a trade secret, Jerry," confided Ruben, "If you promise to share it with every tech you meet. If you put an N-connector on one side of the wattmeter, a UHF connector on the other side, and then construct two jumpers, you can make life real easy. Cut the jumpers from the Bird instruction chart; one for VHF highband and a second for UHF. On each jumper, put a UHF connector on one end and an N-connector on the other. That way you can match N to N or UHF to UHF or N to UHF. Think about it. Works great, and no more jumper trouble. For this morning though, Karen, use my meter and cable set and get that ambulance done, OK?"

"Sure sounds like a good solution to me," said Karen.

"Now, Jerry," I asked, "What's the scoop on your job with Fred's car?"

"Ruben and I were about to get back to it, Wes," answered Jerry. "The problem is that Fred can't hear his office, but I checked the radio and replaced the speaker. We don't know where to go from here."

"Did you know that Fred was mostly deaf in his right ear?" I asked.

"No, I didn't know that," echoed Jerry and Ruben together.

"It happened a few years back when he was wrestling a gun away from a bad guy," I continued. "The bad guy's gun went off right next to Fred's ear. He hasn't been able to hear very well ever since."

"Say," said Jerry, "Maybe that's the reason he can't hear the radio. The last radio he had was a dash-mount with the speaker sort of right in his face. This radio has the speaker buried under the seat out of sight and muffled, too."

"I think you're on to something, Jerry," I said. "How can you fix it and still give him the concealed radio that he wants?"

"I have an idea," beamed Jerry. "You probably didn't know it, but Fred's car doesn't have a broadcast radio. I took it out and concealed a recorder in the dash for Fred. How about if I wire his radio to feed the old dash speaker for him. That'll put quality audio right into his face, and maybe he'll hear his office OK."

"Jerry, you surprise me," I said.

"You sure do," added Ruben.

"Me too," Karen butted in, "and because I'm done with the ambulance, I'll give you a hand. My next job, that pickup truck, will be a piece of cake, and we'll all be done by lunch."

"Well Jerry," I said after Fred came by and picked up his car, "you sure had a happy customer. Just what is it you credit for your success, if I may ask?"

"I remembered what I learned in radio school," gloated Jerry, "The instructor used to tell me every day 'Jerry, you won't get anywhere if you fix the symptoms and not the problem.' This was never more true than with Fred's symptoms."

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Radio communications improve services on forest lands

Communications system designers with radio frequency and funding limitations find ways to deliver the best possible coverage. Often, interagency communications requirements lead to using VHF highband channels.

By Don Bishop

Workers in the nation's forests carry out duties as commonplace as insect control, as dangerous as fighting fires and as vital as saving lives. Without adequate radio communications, their daily tasks would cost more, fighting fires would be more perilous and it might be impossible to respond to emergencies fast enough.

"We have aircraft that fly every day during the winter fire season," said David Campbell, a forester in Louisiana. "The pilot looks for smoke, and when he finds smoke, he radios the dispatcher in Natchitoches to give the location. The dispatcher calls whatever unit is in the area and sends it to the fire."

When a fire is burning, the plane circles the fire and tells foresters where the fire has jumped the fire lines. At times, information from the pilot is critical. "On one particularly bad fire, the crew that fought on the fire line didn't know it, but the fire was crowning trees ahead of them and advancing on them quickly," Campbell said. "The pilot told them to get out of there, and that warning saved their lives and the equipment for sure."

Campbell is with the South Natchitoches forestry unit. "The Natchitoches office covers four parishes for District 6 of the state forestry service, including Sabine, Red River, Desoto and Natchitoches," he said. "We use radios on a daily basis for communications. We have radios on fire plows and tractors. We have hand-held radios to use to communicate with one another while fighting fires."

The forestry units use radios on a routine basis to report weather conditions and fires to the office in Woodworth. "With these reports," Campbell explained, "the central office can keep up with all of Louisiana's fire districts and record the information. For example, all of the parishes report daily rainfall."

Campbell added that his hand-held radio gives him a sense of security. "If I go into the timber, I carry my hand-held radio," he said. "If something happened to me, I could call someone. It's definitely a safety factor."

Bishop is editorial director.

Oregon floods

Radios commissioned for the forestry service are not used only to fight fires that blaze when rainfall is light and the timber is dry. For example, they were called into use in Columbia County, OR, during 1995's spring floods that affected 355 square miles of territory. "We used our radio system for coordinating Red Cross efforts," said Clare Wren, communications manager for the Oregon Department of Forestry. "We helped the Red Cross as it assisted people in getting their homes cleaned up."

The state's forestry radio communications network also supports search and rescue efforts in combination with the Air National Guard, U.S. Forest Service and search-and-rescue organizations.

Even though Oregon's network of 44 repeaters designed for forestry communications supports other activities, its principle purpose is to help with the suppression of fires during the active season from June to September.

Asked what new technologies or features he would like to see offered by radio equipment manufacturers, Wren said, "We try not to let technology rule us. Instead, we want to define how we need to do business 10 years into the future and to foresee what technologies will be necessary."

Examples of technologies that are expected to be useful include automatic vehicle location (AVL) equipment combined with Global Positioning System (GPS) hardware to provide accurate position information about heavy equipment used during fire suppression. Wren also said that a mobile data capability for mobile-to-mobile and mobile-to-base communications would be helpful.

Cellular and satellite

The forestry department is equipping certain outlying units with cellular telephones. "The cellular phones make possible long-distance communication as well as a more secure method of communication compared to open-air radio," Wren explained. "Also, the department has entered into pilot program with American Mobile Satellite to test 10 mobile units in western Oregon to see what coverage we have in that hilly territory." The state police are already taking part in the pilot program, which is expected to last 90 to 120 days. After the forestry department joins the program, Oregon's military department will run a test, too.

"The satellite communications will be press-to-talk," Wren said. "You can make a group call to talk with everyone within the group. The forestry department will have its own group. To call an individual unit, you access the satellite and call an identification number, and the unit at the other end rings like a telephone."

Wren described cellular phones and satellite communications as extra tools, but he does not foresee them as replacing existing radio systems. Foresters work in remote areas not likely to be served by cellular systems that are built to reach populated areas and areas with vehicular traffic. Satellite communications may not reach into all locations where a view of the sky is obscured.

At present, the VHF highband carries all of Oregon's forestry radio communications. "We are on the verge of obtaining UHF," Wren explained, "but we are not there yet. We have about 44 repeaters statewide on six frequency pairs. The

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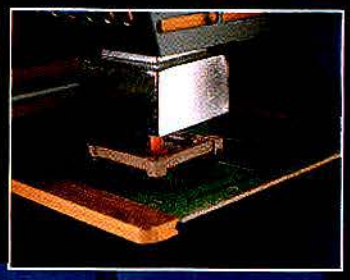

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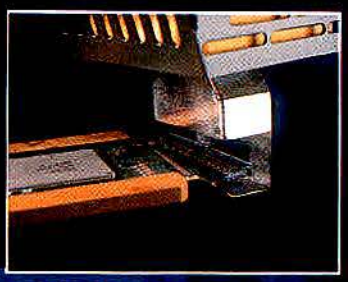

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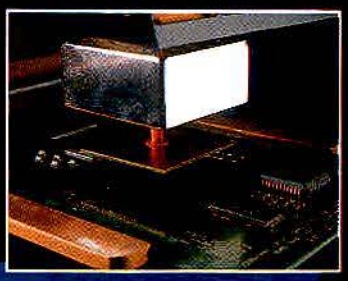

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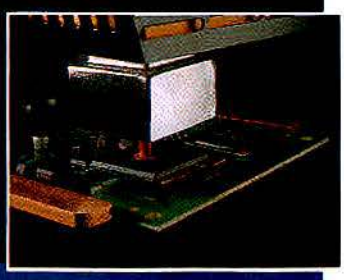

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system includes mobiles, portables, base stations and repeaters. We use a portion of the Oregon Department of Transportation's 6GHz analog microwave systems to control our mountaintop repeaters."

The repeater system is not linked. Instead, it is divided into 13 districts. Each district has its own frequency pair. A given district has from one to five repeaters, depending on the district's size and terrain. Although all of a district's repeaters are on the same frequency, each repeater uses a different subaudible tone control frequency.

"All repeaters in a district hear all of the radios," Wren said, "but they only key up when the proper tone is selected."

This configuration can lead to co-channel interference. For example, a radio used on a 6,000-foot mountain can place a strong signal on all repeater input frequencies for 100 miles. The radio might block other signals from the other repeater's input, but no interference would be heard because the subaudible tone control would keep the other repeater silent.

"We have lived with this type of interference for years," Wren said. "We are waiting optimistically for FCC to free up new interstitial channels so we can license on 7.5kHz splits in highband. That will solve many of our co-channel interference problems within districts and between districts."

One relatively new project for the forestry department is centralized dispatching. The dispatching function for as many as five districts is being combined with dispatching for the U.S. Forest Service and the Bureau of Land Management to use one dispatching location.

As is done in Louisiana, the Oregon forestry department uses aircraft, including a Cessna 414 and a Part Navia equipped for aerial photography. Radio equipment on the aircraft can communicate with the U.S. Forest Service and other agencies besides the state forestry department. This capability is useful when the aircraft are used for insect and bear surveys in cooperation with other agencies.

Besides his work with the state of Oregon, Wren is involved with national spectrum allocation matters in his role as president of the Forestry-Conservation Communications Association (FCCA). FCCA has been actively involved in subcommittees of the Public Safety Wireless Advisory Group (PSWAG), a committee with a mandate from Congress to formulate radio spectrum needs for public safety through 2010.

South Dakota

When it comes to spectrum allocations, "Everything is in kind of a turmoil," said Les Childers, a technician with South Dakota State Radio Communications, the agency that oversees radio communications for the state, including forestry communications. Blocks of VHF and UHF land mobile frequencies assigned for specific purposes, such as forestry communications, are subject to refarming, which may mean frequency reassignments for other purposes and with new technical and regulatory requirements. "We don't know what will happen to those blocks, whether they will be left for government use or auctioned. What we would like to see is that when frequencies are split [creating more channels], frequencies for forestry, local government and police use stay in that group."

Childers explained that funds for upgrading radio communications systems tend to be more available during a short period following particularly destructive fires. For example, in 1986, lightning ignited a fire—the Galena Park fire—that burned about 18,000 acres in Custer State

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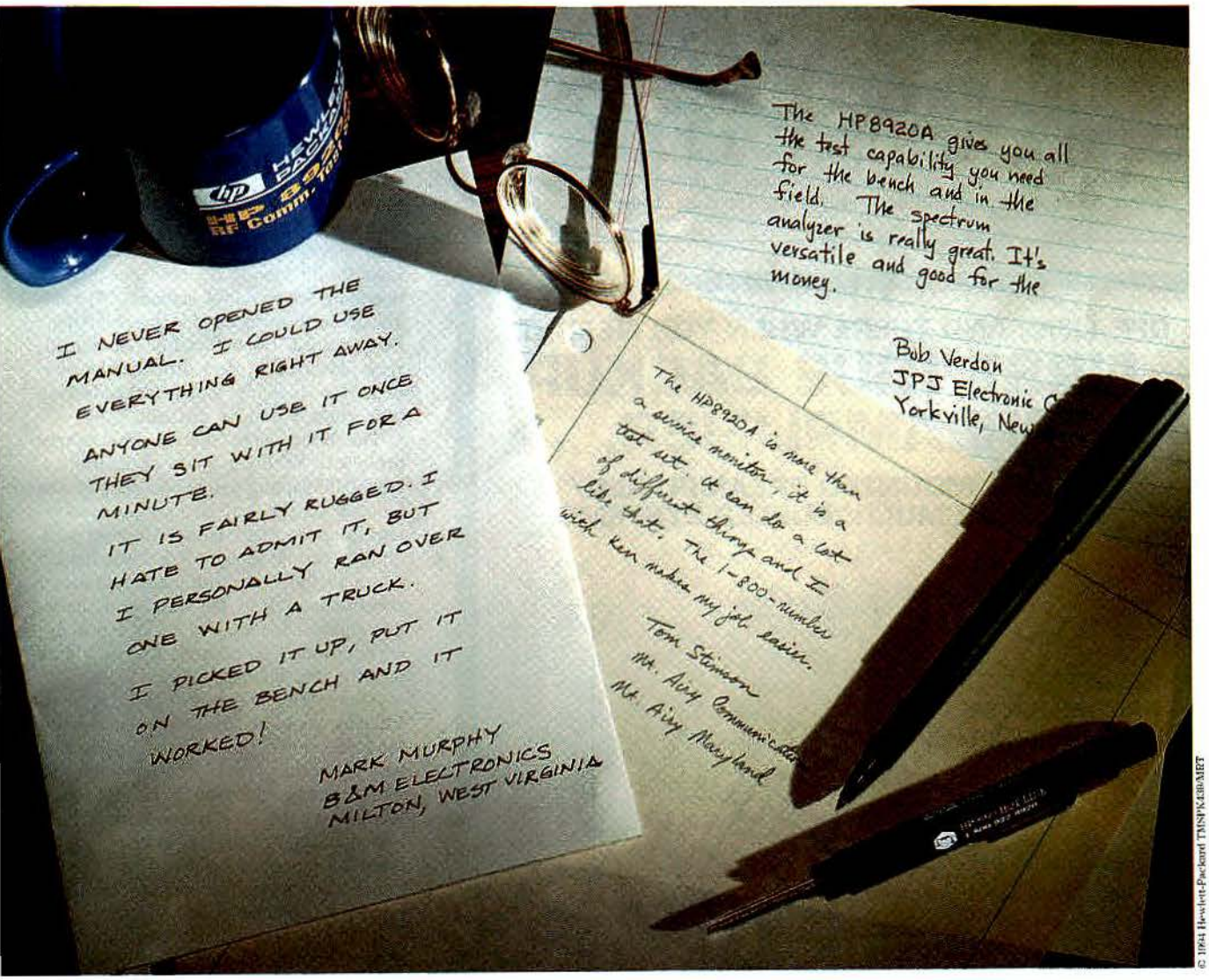

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Park in the Black Hills. A plan had been drawn up during 1985 and 1986 to reconfigure the radio system using 70 channels and including the existing communications resources of local fire, Civil Defense, law enforcement, state forestry and federal forestry agencies. After the fire, funds were made available to acquire equipment for the state forestry department, and the operating plan was developed.

Before the channel plan, Childers said, there were a lot of problems during a fire in the Flint Hills and other burns in the Black Hills. "Communications were rather nonexistent," he said. "The current system was built in response to that. Rather than reinvent the wheel, we used what was there."

The plan is based on the original equipment bought for forestry use in that area during the period following the Galena Park fire. The channels are divided into 12-channel banks that fit 48-channel portables. The first bank is dedicated to state agencies, the second to fire line repeaters, the third to local agencies and the fourth to federal agencies.

Although the system uses five repeater sites with another two yet to be installed, Childers said that interference problems are minimal.

Asked what he would like to add to the system, Childers said he would like to have a microwave system dedicated for forestry department use to link repeaters sites together. At present three sites are linked with microwave, and the rest are operating with control stations. "The advantage with microwave is direct linking," he explained. Control stations cannot always cover such great distances because of terrain shielding, which makes linking with control stations difficult.

The microwave system was nearly achieved. "With one phase of the project, a $950,000 appropriation was supposed to be made for the dedicated microwave system to cover Black Hills," Childers said. "It didn't come about. All that was funded was a $3,500 study with maps, and actual construction fell by the wayside. Usually, the situation is that, if there is a fire, everyone wants to address the problems quickly, and then they forget."

Along with the microwave system, Childers would like to add more mountaintop base stations and repeater sites, and he would interconnect the system with the public switched telephone network for mobile phone calls. The system currently relies on local telephone cooperatives' equipment and programmable radios with Touch-Tone pads. These radios are dedicated for telephone calls.

Although the communications manager is largely satisfied with the system's coverage, he would like to have better coverage in some areas. "The Black Hills is mountainous terrain—not good for radio coverage," Childers said. "Without a high number of repeaters, coverage can be sporadic."

To improve portable radio coverage, the forestry department uses portable fire line repeaters and 450MHz links. "We situate them where we can link back into the microwave system," Childers said. "We can have communications right back to the emergency operations center where all the staging is done."

Successful forestry radio communications takes various forms depending on the expanse of territory to be covered and how many agencies cooperate in providing services to that territory. The safety of life and property, as well as the efficient performance of routine tasks, is improved with the right communications system.

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RF isolation, cheap and easy

Isolation may be best for eliminating AM broadcast signals and induced electrical hum in some communications base station and microwave facilities and where various users of communications equipment share tower space.

By Patrick E. Buller

There are times when the signal from the local broadcast station gets into your station equipment. You don't want it for reasons other than not liking the program content. Your equipment may be in an electrical substation where the power line magnetic field renders your lower frequencies unusable. If so, one or more of the dc/RF isolators shown in Photo 1 below may be for you.

Local broadcast stations use an amplitude-modulated (AM) transmitter connected to a vertical antenna with a minimum of 120 buried radials for a ground plane. The radiated field has a strong ground wave extending as far as several miles from the antenna. If your tower is within the influence of a broadcast tower or electrical substation, you should expect some of this energy to appear in the ground system of your station. Communications towers at a height nearly equal to the quarter wavelength of the AM station frequency not only influence the radiation pattern of the broadcast station, but also provide considerable energy in the ground return of the tower.

Consider the example shown in Figure 1 below right. A tower grounded at its base without other connections will not bother anyone other than to produce pattern disturbance. However, a closed current loop is provided when conductive appendages such as microwave dishes, VHF, UHF and 800MHz/900MHz antennas are attached. Cables leaving the tower at some elevation usually are attached to the electronic equipment, thus providing another current path separate from the tower ground. Often the shunt current is of sufficient magnitude that it interferes with the station ground.

A large percentage of communications facilities use shielded cable grounded at both ends or coax cable to interconnect voice and data circuits to a radio or multiplex channels. This cable often carries current derived from the AM broadcast station's signal—current that will modulate your signal and that represents a form of interference.

Multipoint grounding, or the "ground everything" concept, will not eliminate this problem, it will merely reduce it to some lesser level. One of the simplest

Buller is an electronics design engineer for the Washington State Patrol, Bellevue, WA. He is a member of the Radio Club of America, IEEE, NARTE, ARRL and APCO. He earned an amateur radio license in 1950, a commercial radio license in 1959 and a B.S.E.E. in 1963.

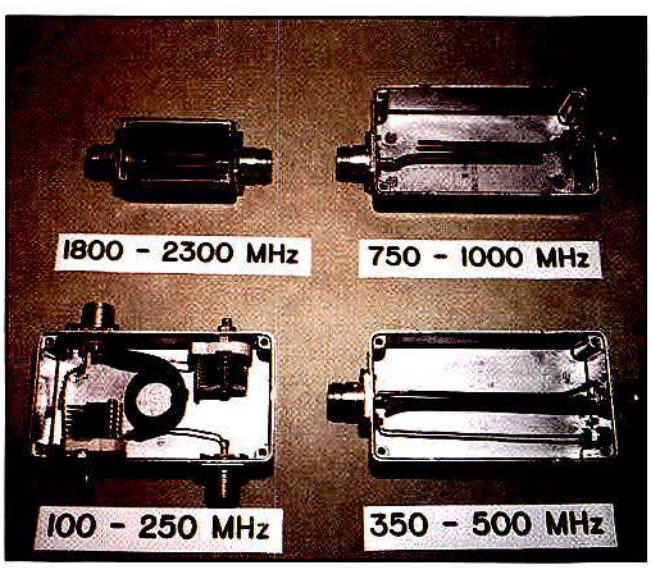

Photo 1. This is the inventory of RF isolators that can be used to troubleshoot and correct interference from induced RF and electrical fields.

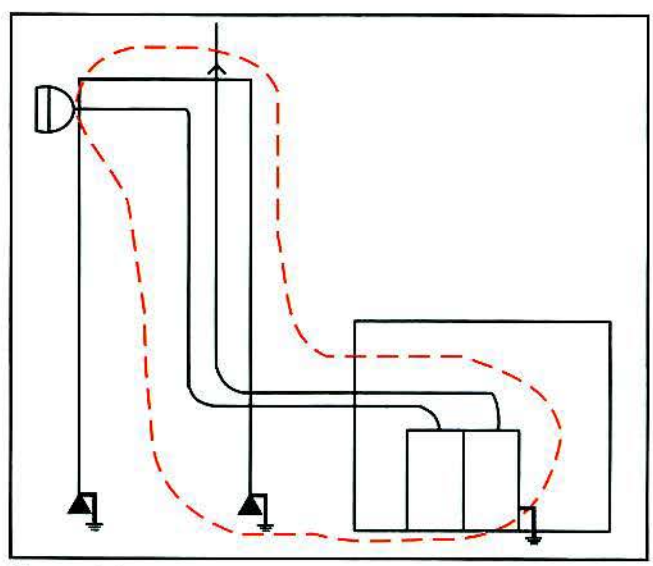

Figure 1. Induced current from an electrical substation or a nearby AM broadcast station flows along the path indicated by the dashed line, causing interference with communications equipment.

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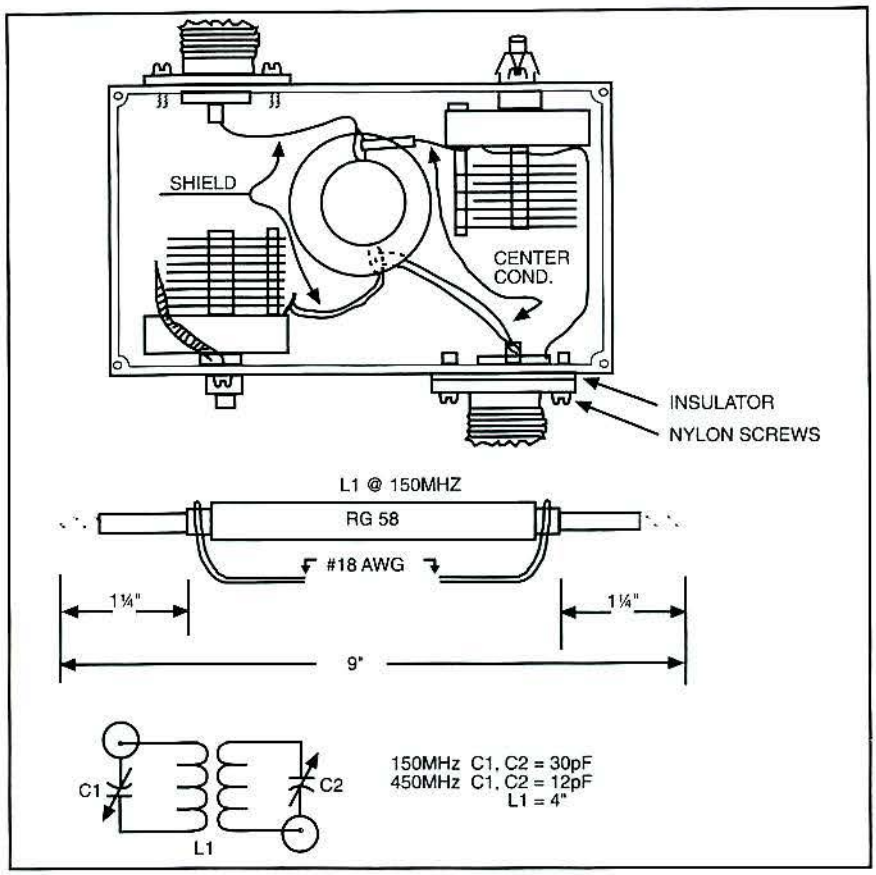

Figure 2. Construction details for the 100MHz–250MHz RF isolator.

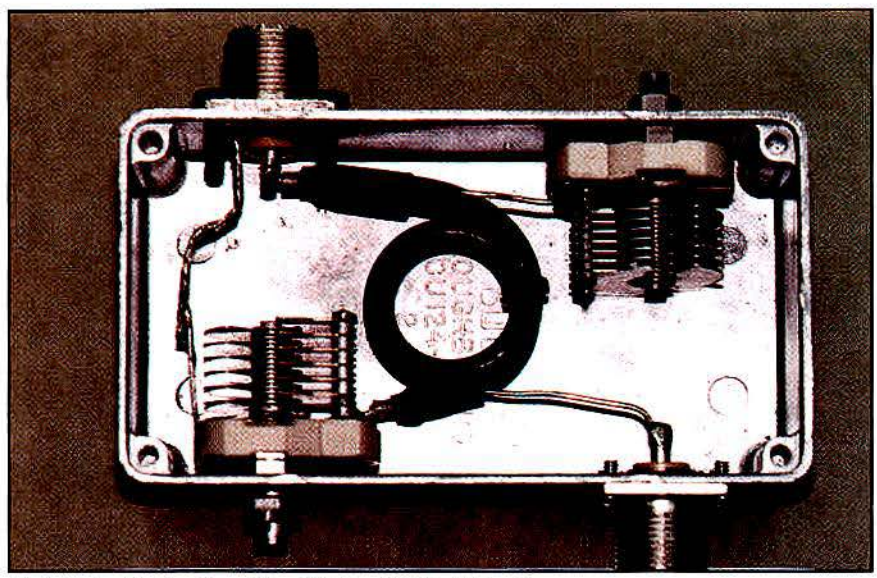

Photo 2. An interior view of the 100MHz–250MHz RF isolator.

methods of interference reduction is to isolate the affected equipment from these ground currents. Research at the Washington State Patrol has resulted in the development of dc isolators. Figure 2 above is a schematic diagram of the 150MHz–170MHz dc/RF isolator that consists of two tightly coupled tuned circuits. To minimize insertion loss, coax cable is used instead of wound coils. Wound coils are cumbersome, and with wound coils, the necessary high voltages cannot be tolerated and low insertion loss cannot be achieved. The cable length shown in Figure 2 is optimum for both maximum bandwidth and minimum insertion loss. The

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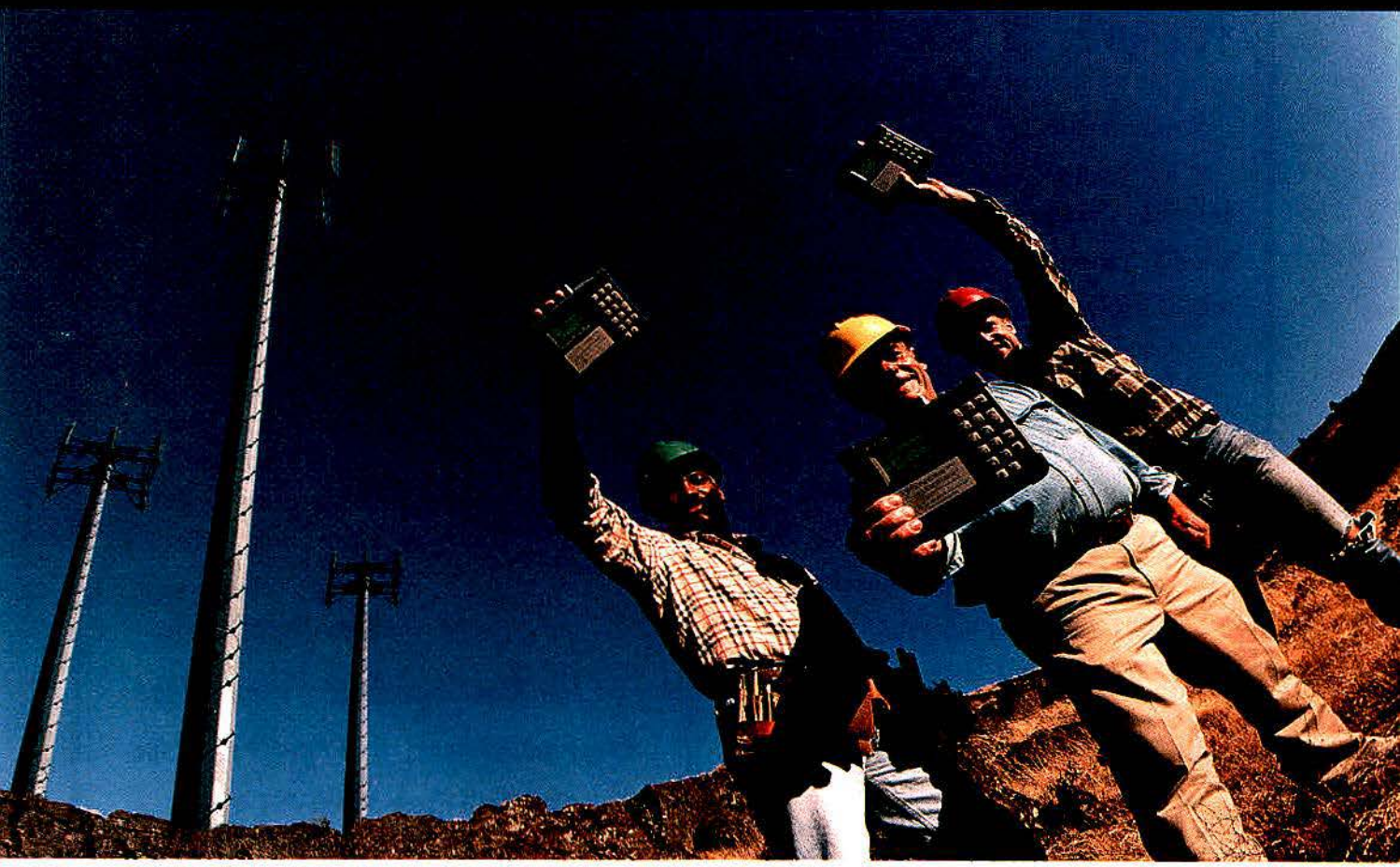

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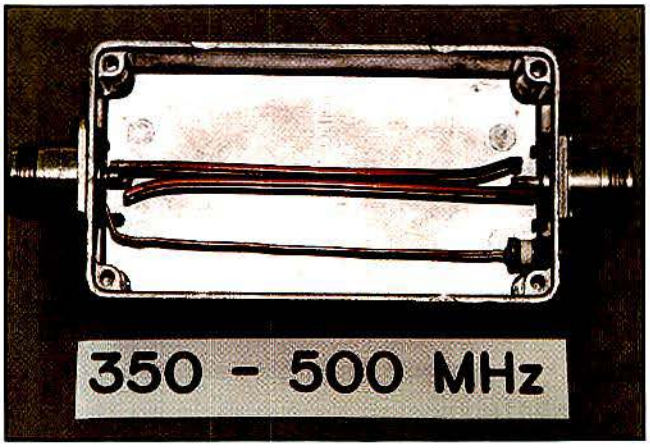

Photo 3. An interior view of the 450MHz RF isolator.

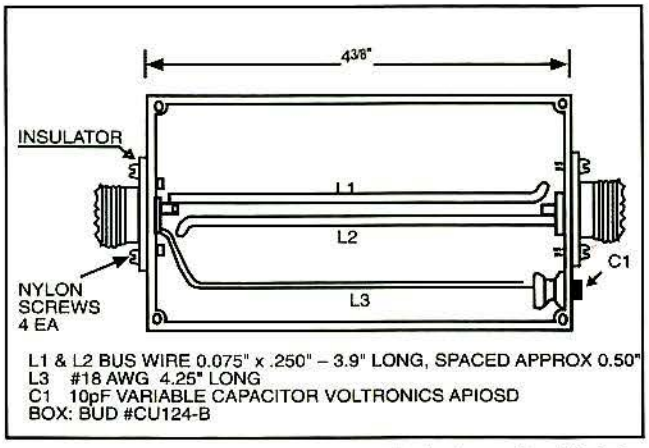

Figure 3. Construction details for the 450MHz isolator with shield wire coupling. Insertion loss is 0.05dB.

cable's electrical length is shortened by adding capacitance for a low "Q" quarter wavelength. (See also Photo 2 on page 32.)

Note that the polarity of the input and output connections does not follow conventional thinking about common ground. Air-dielectric variable capacitors are used not only for resonating the cable but also for handling the RF current from 110W base stations. APC-type variable capacitors normally have the rotor contactor isolated from the mounting screws, making them ideal for the isolated port, but the other capacitor needs to have its contactor grounded. Fixed capacitors may be used if their RF current capacities are adequate. A plot of attenuation vs. frequency yields a straight line from well below 100MHz to well above 200MHz, so it is unnecessary to show it.

The 150MHz, 450MHz and 750MHz–1,000MHz isolators are built in Bud CU142 C cast aluminum boxes with covers. Connectors are "user's choice," although type N fittings are preferred. An essential requirement of construction is that the insulated port connector must be completely insulated from the aluminum box by an insulating sheet with nylon screws for fasteners. The insulator used is 0.020" thick fiberglass cut to fit over the ring of the type N chassis connector. A more suitable material can be used for the

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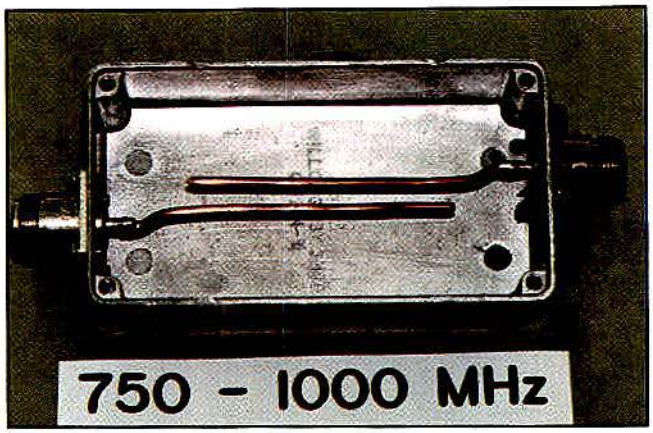

Photo 4. An interior view of the 750MHz–1,000MHz RF isolator.

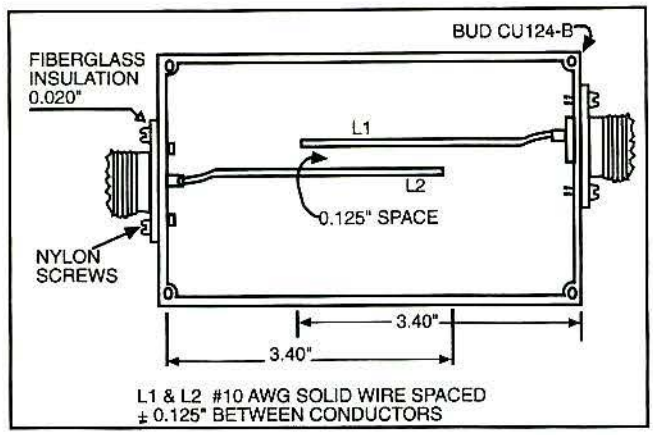

Figure 4. Construction details for the 750MHz–1,000MHz isolator. Insertion loss is 0.05dB.

insulator when necessary. The hole for the connector should be 5/8" in diameter to clear the ring. Drilling and tapping the aluminum box for 6–32 screws is the recommended method of attachment for the coax connectors.

Dc/RF isolators for the 450MHz band can be built with either a 3½" coax line (vp = 0.66) with 10pF capacitors similar to the 150MHz design or parallel lines in a box as shown in Figure 3 on page 34 and Photo 3 on page 34. The parallel transmission line design has insufficient capacitance provided by the insulated chassis connector to the box. To overcome this deficiency, a transmission line of an electrical halfwave is added to transfer the isolated shield RF current to ground, which accounts for the third conductor seen in the photograph. For applications subject to vibration, a stand-off insulator may be added near the ends.

Transmitter power exceeding 100W should use this design. Lower power levels can safely incorporate the tuned coax style. Tuning of the coupled lines is outlined below. The insertion loss of either design is 0.05dB with a bandwidth of 200MHz.

The 750MHz–1,000MHz (Figure 4 and Photo 4 above) and 1,850MHz–2,300MHz (Figure 5 and Photo 5 on page 38) isolators rely on a fixed capacitor, as formed by

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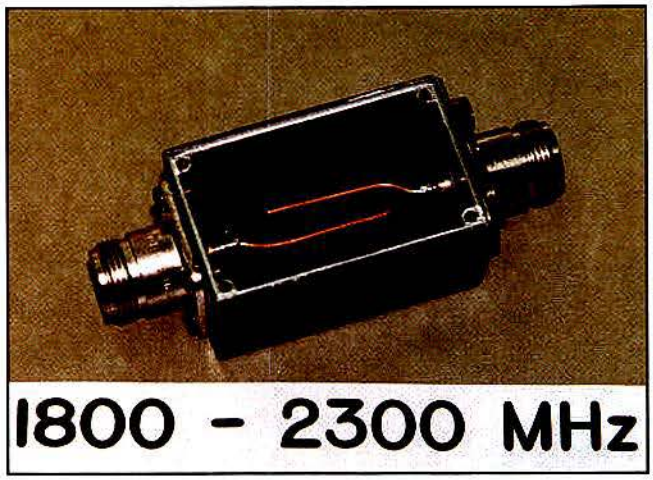

Photo 5. An interior view of the 1,850MHz–2,350MHz RF isolator.

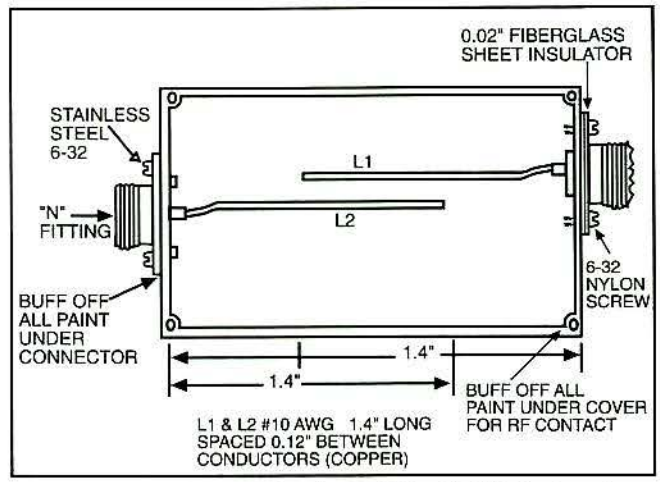

Figure 5. Construction details for the 1,850MHz–2,350MHz isolator. Insertion loss is 0.05dB.

the surface area of the coax connector, insulator and box, for the shield current. This fabricated capacitor is sufficient at these frequencies to produce a low impedance path for the shield current. Additional capacity may be added if the situation so dictates.

The 1,850MHz–2,300MHz device is constructed in a Pomona No. 2417 cast aluminum box. To use this box, all of the blue paint must be removed from around the coax connectors and from the lid grooves. The design of these isolators requires that the coupled lines be a quarter wavelength long inside the box. The primary factors in dimensions are probe length (which determines the frequency) and spacing (which determines bandwidth and insertion loss). If the coupled lines prove to be too short, add some solder to the end. All measurements must be made with the cover in place.

Adjustments are best accomplished using a tracking generator and spectrum analyzer. The length of the coupled lines and their spacing is extremely critical to bandwidth and linearity. Overcoupling (wires

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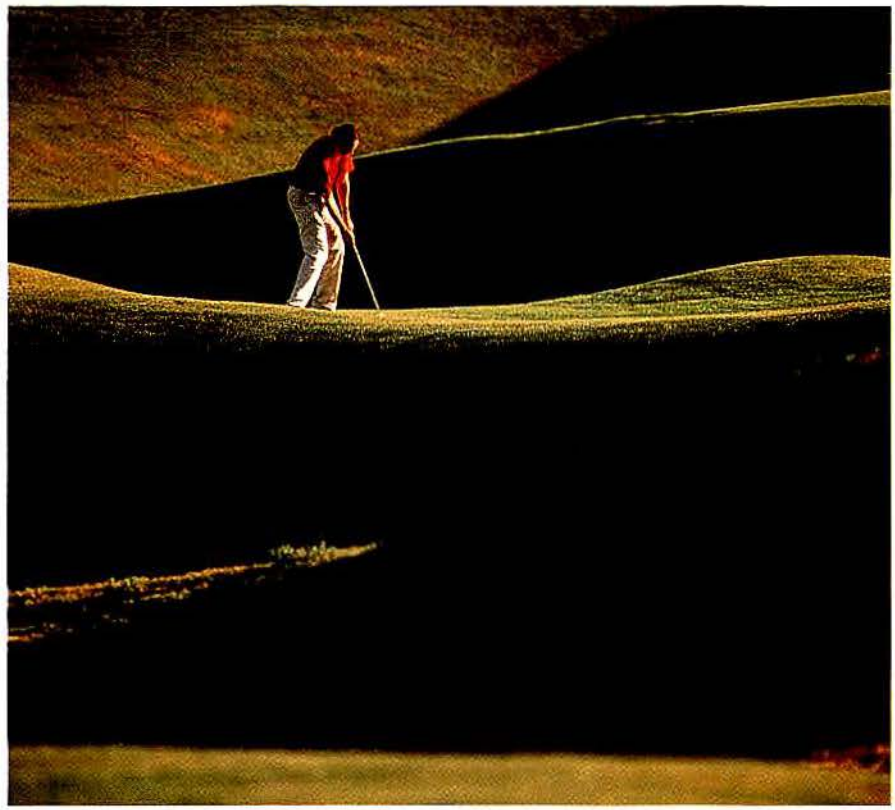

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too close together) increases insertion loss at the middle frequency range. Insufficient coupling not only reduces bandwidth but also increases insertion loss. If narrower bandwidth is desired, tune for minimum insertion loss at the desired frequency. In all cases, ensure that the termination impedance is correct for adjustments. It is best practice to insert a 6dB-to-10dB attenuator at each input and output connector during measurements and adjustments.

For a 6GHz or higher frequency microwave antenna connection, the following method has proved successful. Isolation may be realized at the pressure window by using the electrical insulation provided by the mylar glued to the window face plate. Look at the pressure window and determine whether the mylar is installed on one side. If so, it may be used. Re-install with nylon screws for fasteners.

If the pressure window has a clear piece

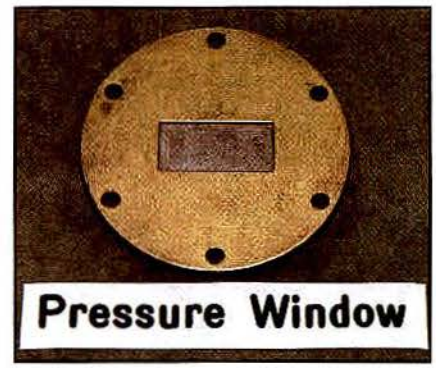

Photo 6. For a 6GHz or higher frequency microwave antenna connection, isolation may be realized at the pressure window. See text for details.

sandwiched between plated disks, remove the window for the following treatment. Place a single layer of heavy-duty polypropylene carton sealing tape, Permacel No. P-919 or the equivalent, on one surface. Carefully cut the tape over the mounting holes so that the nylon screws will not fold over the tape on the face plate as shown in Photo 6 above. Install with the tape facing

Insufficient coupling not only reduces bandwidth but also increases insertion loss. If narrower bandwidth is desired, tune for minimum insertion loss at the desired frequency.

the choke flange and nylon screw fasteners. It has been determined that this tape does not contribute significant additional loss. Check the installation for continuity between waveguide connections. (There should not be any.)

The object of this procedure is to dc/RF-isolate all transmission lines from the equipment by not allowing current supplied by the tower to return to ground through the baseband cable, audio lines, data ports and the like. Although some lightning protection may be realized by this method, it is not the intended result.

Here is an example of how successful this method can be. A 5kw, 1,280kHz AM broadcast station one-half mile from a

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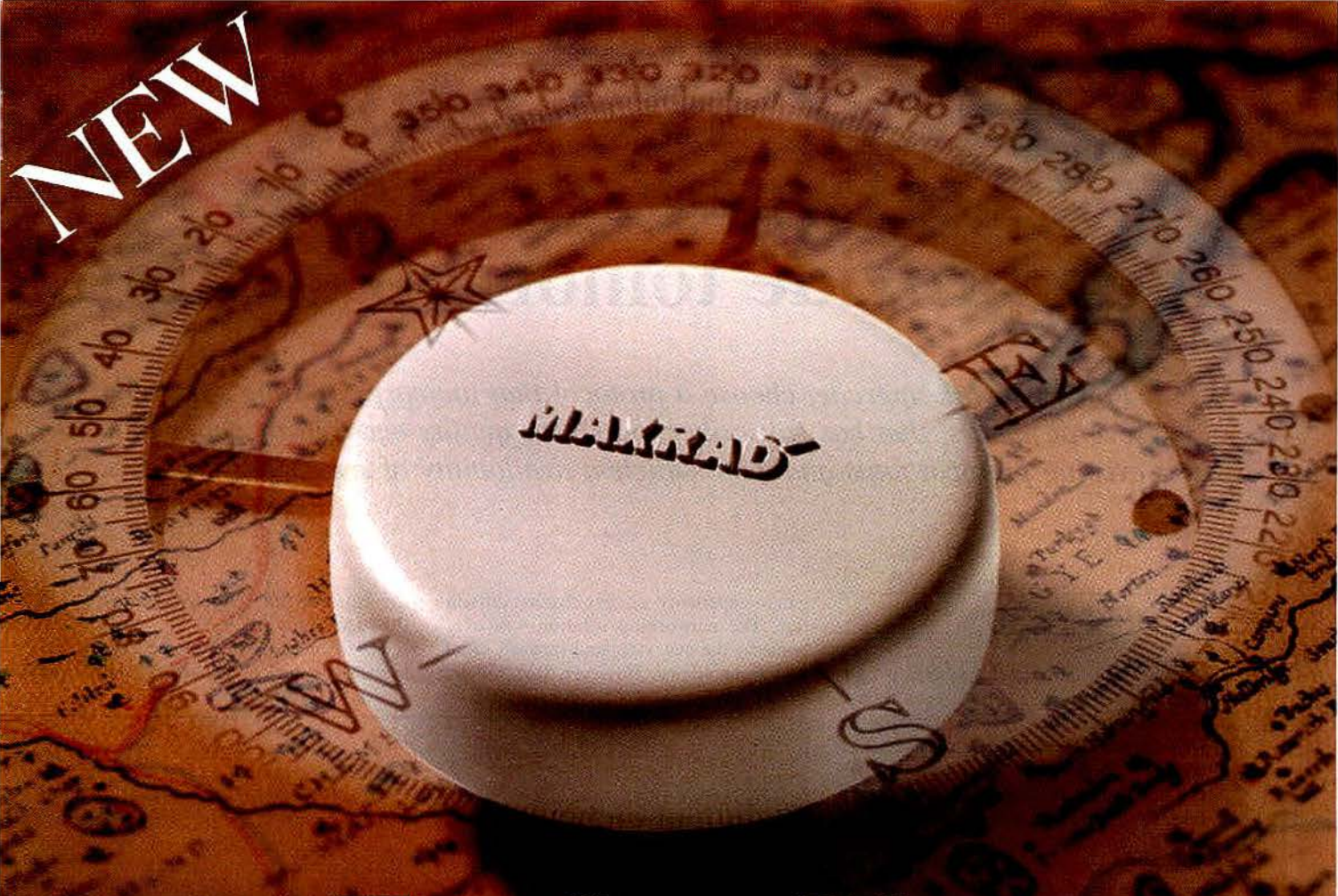
large microwave installation with four 6GHz microwave antennas and three VHF antennas on a 200-foot tower affected 32 digital data ports and all microwave basebands, sending the 1,280kHz AM signal at 15dB below test tone in all directions. The level increased dramatically when test cables were attached to the baseband for measurement. By treating all antenna cables with dc/RF isolators as described and by removing a common ground wire located at the bottom of the racks, tower ground current was removed from the equipment, thus reducing the AM signal by 69dB at the communications equipment.

It is much easier to isolate an antenna transmission line than it is to treat 672 voice-grade lines by process of elimination.

Here is a second example. Two county agencies shared the same power supply. Each had 2GHz microwave radios with multiplex in separate rows of equipment and interconnecting baseband cables. The ground loop consisted of the transmission line of radio No. 1 going up the tower leg with coax connected to the antenna, providing a ground at that point. The other county agency was on the opposite side of the tower with its transmission line going from radio No. 2 to antenna No. 2. The silicone rectifier (SCR)-regulated battery charger in the middle of the loop caused a magnetic field to induce 120Hz interference plus all of the harmonics associated with SCR switching directly into the cabling. Installing 2GHz isolators in the transmission lines close to the radios eliminated the problem.

You may recall a similar situation in your own systems. There may be installations where communications equipment of various users share tower space. Isolation may be the only way sharing is possible.

Several of these devices may be kept on hand for troubleshooting. It is much easier to isolate an antenna transmission line than it is to treat 672 voice-grade lines by process of elimination.



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VSWR:	1.5:1 maximum
Input Impedance:	50 Ohms

ELECTRICAL SPECIFICATIONS	MODEL GPSA
Description:	active receive GPS antenna
Center Frequency:	1575.42 MHz
Bandwidth:	2 MHz minimum
Pattern:	hemispherical
Polarization:	R.H.C.P.
VSWR:	1.5:1 maximum
Input Impedance:	50 Ohms
Preamplifier Gain:	16dB typical
Noise Figure:	2.5dB maximum
Passband Width:	20MHz minimum
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Yesterday's networks may provide tomorrow's profits

For a network upgrade, choose a protocol that increases existing speed by several factors, that has subscriber units with quality equal to or better than existing protocol units and with sufficient availability of subscriber products.

By Nigel Pestell and Don Siperko

How well your one-way system is optimized is a subjective matter, even though the problems involved with optimizing are well-known. If your batching algorithms and RF network optimization provide adequate paging airtime in the busy hour, fine. Or maybe that was *yesterday*. "Adequate" airtime may not exist *today*, and given the paging industry's projected growth, it most certainly will not be here *tomorrow*.

The paging business is highly competitive. Subscriber-unit growth is critical to success. As more people take advantage of the convenience of pagers and messaging devices, the old business equation applies: the greater the revenue, the greater the profits. The problem that most operations managers face is how to get more revenue out of existing channels.

The radio spectrum is a finite resource. Each paging system channel has a specific limit to the number of pagers it can support. This capacity is defined by the baud rate of the transport medium, the *busy hour call average* (BHCA) and other factors such as message length. As the number of paging calls increases, available airtime is consumed until the channel reaches its limit. Hence, management, investment and often regulatory decisions must be made to maintain continued growth.

Since the early '80s, POCSAG baud rates have increased to a point where the protocol's over-the-air integrity was challenged. When pushed to 2,400 baud, not only was the POCSAG code stressed, but many existing transmission networks began to experience synchronization difficulties. The networking solution was overcome by the new store-and-forward simulcast technologies. However, that still left the trusted, but outdated and stressed, POCSAG protocol.

For the industry to continue to grow and to meet the demand for improved one-way

Pestell is communications manager for the Motorola Advanced Messaging System Division, Fort Worth, Texas. Siperko is a senior staff engineer for the division and is a member of the Flex Change Control Board.

Why is four-level the key?

To operate paging systems more efficiently, as much data as possible must be packed into a channel of finite bandwidth. To help analyze the problem, we'll turn to Harry Nyquist (1889–1976). Nyquist was an inventor and physicist who spent time working on the theory of RF communications. From Nyquist's theorem, a data rate of 2*B*b/s (with the variable *B*) can be transmitted through a channel with a bandwidth of *B*Hz. Put simply in a normalized value, this theory means that data can be transmitted at the rate of 2b/Hz. In this case, the data rate is the same as the symbol rate (i.e., each symbol represents one bit of data). Assuming a bandwidth restriction of *B*Hz, then the only way to achieve a higher data rate is to encode the data so that each symbol transmitted on the channel represents more than a single bit of information.

With multilevel encoding, the effective data rate given by Equation 1 can be expressed as:

$$R = 2B\log2(M) \quad [1]$$

Multilevel encoding, in effect, increases the spectral efficiency of the channel by a factor of *M*. Equation 2 represents this result by normalizing the throughput per hertz of bandwidth.

$$R/B = 2\log2(M)\text{b/Hz} \quad [2]$$

As an example, assume that a system is currently using a 1,600-baud, two-level transmission. From Equation 1, the data rate is 2*B* where *B* equals 800Hz. With *M* equal to two, the normalized data rate is again 2b/Hz. Suppose we want to transmit 3,200 baud in a bandwidth of 800Hz. If we tried to transmit one bit per symbol, at least 1,600Hz of bandwidth would be required to comply with Nyquist's theory. On the other hand, if we use four-level modulation in an 800Hz bandwidth, the data rate from Equation 1 would be 3,200 baud. From Equation 2, we see that we are now transmitting four bits of data for each hertz of bandwidth. What we have achieved is an increase in spectral efficiency by a factor of four as compared to two-level modulation, which yielded a gain of only two.

Nyquist's theory applied in a practical application makes a four-level modulated code a much more spectrally efficient protocol than the previous two-level POCSAG code.

Binary FSKNRZ

Most binary paging formats use the modulation scheme of *frequency-shift keying, no return to zero* (FSKNRZ). With this technique, a binary bit of information is represented by a particular frequency in a set of signaling frequencies. The information is transported by using a frequency that causes the instantaneous change of the carrier around its assigned center frequency. We can easily determine the number of frequencies required in the signaling set from Equation 3.

$$M = 2^B \quad [3]$$

communications, a new universal data transport protocol was needed. Where one-way POCSAG was the high-speed code for the '80s, a new approach was needed to meet the challenges of the next century. Industry analysts at MTA-EMCI, Washington, project the growth of global paging to escalate from its present 70 million subscribers to 137 million subscribers by the year 2000. Combining existing POCSAG technology with whatever new technology meets tomorrow's needs obviously makes the most sense.

Since 1989, several new paging transport protocols have been introduced. First on the scene was the European Radio Messaging System (ERMES). This was followed in 1993 by Motorola's Flex family of transport protocols. Philips, with the assistance of the software company Envoy, developed and introduced the *advanced paging operators code* (APOC), an advanced version of POCSAG, in 1994. All of these enhanced-code formats use four-level modulation, or a combination of both two- and four-level modulation. To make more efficient use of existing POCSAG channels, increasing both revenue and profits, a four-level modulated format is the answer.

Available 4-level protocols

ERMES is a 6,250-baud, four-level, modulated protocol. It was commissioned in the mid-1980s by the European Union (EU). A robust code, it provides improved spectral efficiency. Perhaps its greatest contribution is its standard of network interfaces. To conform with its roaming specification, ERMES requires compliance to a block of 16 defined VHF channels. Each member nation or service provider is allocated as many as four channels. Compliance to the block of 16 VHF channels often places impossible demands on spectrally stressed urban centers. Although not associated with the code's performance, beta tests in Germany ran into unforeseen cable and television interference (TVI) problems. The German Bundespost has yet to resolve these spectrum problems with its EU neighbors. To date, France is the most successful ERMES implementer, with three regional systems operating in and around Paris.

Although Europe is considered the stronghold of ERMES, the fortress is beginning to show signs of cracking. The German experience with TVI and cable interference has weakened the resolve of the German government to follow the EU doctrine of excluding other protocols. Because of these problems and other public pressures, the German government recently issued a new paging license to DFR, a German communications company. The

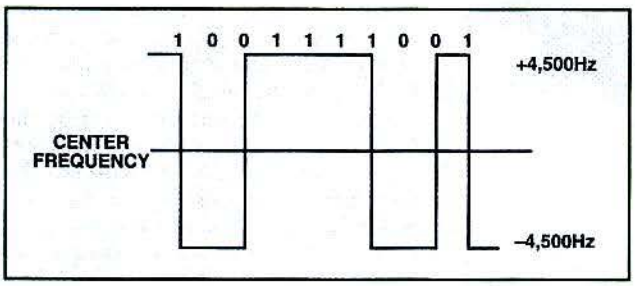

Figure 1. An example of POCSAG 2-level modulation.

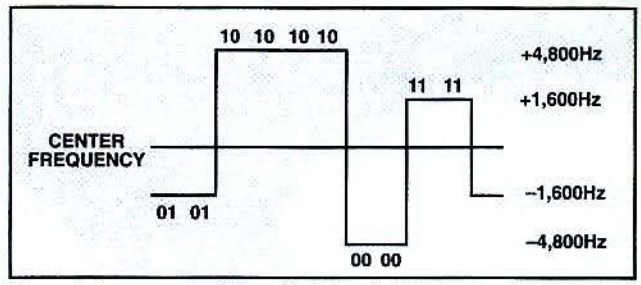

Figure 2. An example of Flex 4-level modulation.

In Equation 3, M is the number of modulated frequencies required in the set, given the objective of transmitting B bits of data per element. As an example, with 1,200-baud POCSAG, B equals 1; therefore, two modulated frequencies are required in the signaling set. The modulated frequencies are commonly known as the binary deviation and are typically ±4,500Hz. If a binary 1 is represented by ±4,500Hz and a binary 0 is represented by –4,500Hz, the instantaneous frequency appearing on the channel will be $f_c \pm \Delta f$, where f_c is the assigned center frequency and Δf is the frequency of the signaling element. (See Figure 1 above left.)

In addition, the data rate affects deviation. If we assume a data pattern of alternating 1s and 0s in the 1,200-baud POCSAG protocol, then the rate of change of deviation transitions between $f_c + \Delta f$ and $f_c - \Delta f$ will occur at a rate of 1,200 times per second. To implement a bandwidth-efficient protocol, four signaling modulation frequencies are required, with each frequency representing 2b of data. For example, in Flex technology, the set of modulation frequencies are defined as +4,800Hz, +1,600Hz, −1,600Hz and –4,800Hz relative to f_c. (See Figure 2 above right.)

Deviation levels

In two-level modulation formats such as POCSAG, there are only two possible deviations around the assigned center frequency, which is typically ±4,500Hz. The data sent to the encoder determine which deviation to be selected. In most instances, the data entering the encoder contain information to control voltage levels supplied to the modulator. Depending on the control voltage information, the deviation swings either positive or negative. Because there are only two elements in the signaling set described above, only two distinct voltage levels are required.

As the number of frequencies in the modulation levels increases, the number of voltage levels used to drive the modulator must also increase. In Flex protocol, four voltage levels are required to select the four possible deviations listed above. Which voltage level (or deviation) is selected depends directly on the data received by the encoder. For example, if the two-bit sequence received is 1,0, then the encoder will output a control voltage to select +4,800Hz. If the bit sequence is 0,1, then the encoder will output a different control voltage to select –1,600Hz. (See Table 1 at the left.)

Table 1—A deviation table example for Flex

Bit Sequence	Deviation in Hertz
1,0	+4,800
1,1	+1,600
0,1	−1,600
0,0	−4,800

license provides DFR with the right to test and, with Bundespost approval, implement other transport protocols. DFR publicly supported the one-way Flex protocol and, with Bundespost approval, will begin commercial service using the 3,200bps Flex in Spring 1996.

ERMES, which is not compatible with POCSAG, would require a complete trade-out of existing infrastructure equipment and associated pages. This action would be expensive and time-consuming, and it would place existing customer revenues at risk. Hence, ERMES does not qualify as an integrated-channel, POCSAG growth solution.

As a four-level protocol, Philips' APOC was a late arrival. It offers many features, including spectrum efficiency, a robust code and an effective transmission speed of 6,400 baud. Possibly its most attractive feature is its compatibility with POCSAG, which allows it to cohabit the same channel with POCSAG. By using a data dictionary embedded within the pager software, APOC reduces the over-the-air data required to complete a given message. It is claimed that, depending on the amount of message commonality, the data dictionary feature can increase the throughput to 380kb/hr.

APOC's late arrival has undoubtedly placed it last behind the Flex and ERMES protocols in the race to become the successor to POCSAG. It is reported that an APOC system beta test was conducted in Great Britain in 1995. However, little international media attention was given to the beta test and, to date, no commercial APOC system build-out has been reported. In the global arena, little interest in APOC has been shown. Further, APOC and ERMES lost to the Flex protocol when Japan selected a version of the Flex technology called Flex Time Diversity as its national high-speed paging protocol.

Since the Flex protocol was announced in 1993, this family of transport protocols has clearly become the global leader. Motorola has invested heavily in the ongoing development of this transport protocol family and is committed to maintaining its evolution as the wireless world evolves. The January 1996 announcement by the Chinese Ministry of Posts and Telecommunications of China's adoption of the Flex transport protocol secures it as the global de facto high-speed transport standard. The Flex protocol was designed to be backward-compatible with POCSAG. Messages in both the Flex and POCSAG protocols can be batched in a terminal and broadcast using the same transmitter network. One-way Flex is a robust protocol that delivers messages even in high-fade areas. Its flexible baud rate allows delivery at 1,600bps, 3,200bps and 6,400bps. In the lower delivery speeds of 1,600bps and 3,200bps, it can operate as either a two- or four-level modulated code. This feature allows carriers to immediately start a progressive migration toward increased capacity, higher speeds and increased profits without a heavy financial outlay. The Flex family of protocols is not frequency-dependent, and the protocols provide a graceful and financially manageable migration path to high-speed paging.

What also sets the Flex family of protocols apart from the other contenders is its highly publicized two-way paging technology. The two-way Flex protocols, ReFlex and InFlexion (which provide data and voice features), have reportedly sent the ERMES Memorandum of Understanding Committee, known as the MoU, back to the think tank.

To date, our company has signed 30

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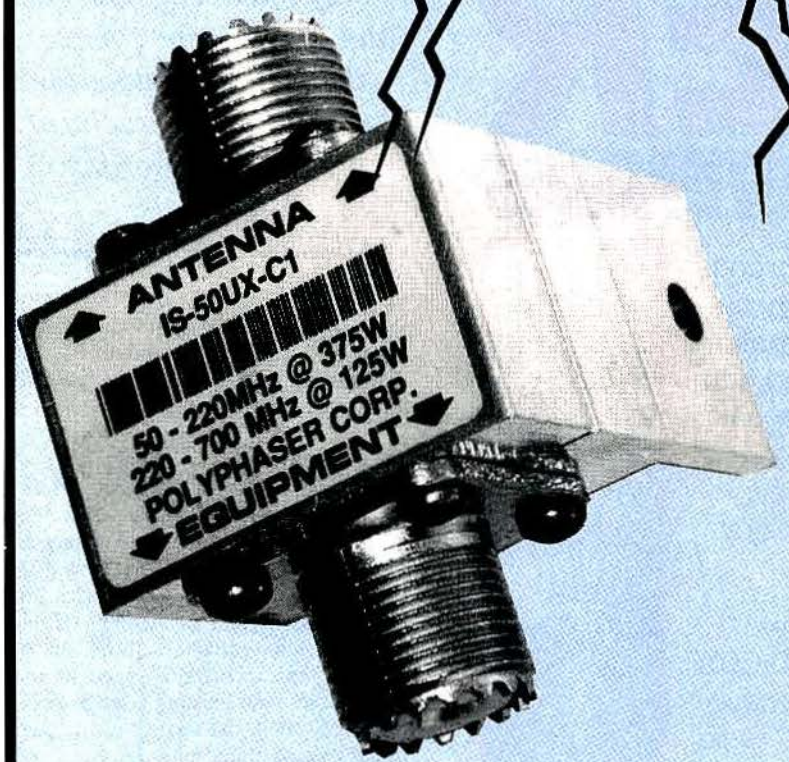

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manufacturing licenses with other companies for Flex technology. These companies will produce pagers, infrastructure and test equipment. Multiple vendors ensure both a stable technology and an adequate supply of products. Among those that have signed manufacturing licenses are NEC, Ericsson and Glenayre.

Following its commitment to make access to the Flex technology simpler, our company announced in September 1995 the availability of Flex protocol chip sets. Since the September announcement, Texas Instruments, Motorola Semiconductor and Taiwan's Industrial Technology Research Institute (ITRI) have manufactured and marketed the chip set product. The Flex protocol chip sets will make the technology easily available to anyone wanting a high-speed wireless protocol. Chip sets will provide the wireless transport solution to the personal computer (PC) market and other consumer electronic manufacturers whose technology is moving us ever closer toward the wireless world.

One distinct advantage to Flex and its chip set technology is that it is open-licensable and controllable. Control and future developments of the Flex standard will rest with the industry leader, while the distribution of the chip sets will be available from multiple sources at competitive pricing. The industry needs to avoid the random and diverse development that occurred with POCSAG after the British Post Office gave up control and development of the code. One singular Flex protocol standard will reduce pager complexity, manufacturing costs and retail pager prices.

Multiple ... offerings in transport protocols not only make engineering decisions more complex, they tend to dilute the cost benefit associated with ... subscriber products.

Choosing a transport protocol

Multiple and often confusing offerings in transport protocols not only make engineering decisions more complex, they tend to dilute the cost benefit associated with the volume production of subscriber products. To assist you in making a choice, here are some guidelines. First, the new protocol has to offer a speed increase greater than your existing code by several factors. Second, the quality of the pagers or messaging units must be equal to or better than existing POCSAG units. Remember, with any new technology, there are increased risks. Many service providers have suffered business reversals when new pagers failed to meet their customers' expectations. Third, and most importantly, is the availability of subscriber products. Are the pagers manufactured in your country? Do the vendor's local or multinational growth plans have sufficient capacity to avoid shortages and delays in delivery? A secure and stable international supply of paging products can be a critical factor in controlling costs and securing tomorrow's profits. Adding capacity to existing channels involves vision and planning. However, growth and additional profits can be found in yesterday's networks.

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Leading the Way in Digital Radio Systems Technology

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Getting more from your spectrum analyzer—Part 2

By Harold Kinley, C.E.T.

Last month we talked about using preamplifiers ahead of a spectrum analyzer in order to boost the weak signal performance of the instrument. Such amplifiers need not cost a fortune! for example, a gallium-arsenide field-effect transistor (GaAs FET) wideband preamplifier covering the frequency range from 1MHz to more than 1GHz and featuring adjustable gain from −3dB to +20dB and a noise figure of 1dB–2dB can be purchased for less than $100.

In an emergency, a simple cable television (CATV) preamplifer can be used, even though the system impedance is 75Ω instead of 50Ω. The cost of these preamplifiers is $25 to $30. You might be surprised at what you can see with the preamp ahead of the spectrum analyzer.

Increasing the dynamic range

There are many times when you might need to view a signal in the presence of a much stronger signal. For example, you might like to measure the second harmonic of a transmitter signal. Obviously, if the second harmonic is present, so is the carrier, and the carrier is going to be at a much higher level. The dynamic range of the spectrum analyzer does not extend to the normal difference between the carrier and the second or third harmonic.

This problem can be solved by the use of a filter to reduce the level of the carrier at the input to the spectrum analyzer while allowing the second or third harmonic to pass virtually unattenuated. In reality, the dynamic range of the spectrum analyzer is not extended; the difference between the two input signals to be viewed is simply compressed.

It is important to remember never to exceed the *maximum input level* specification of the spectrum analyzer. Do not confuse the maximum input level specification with the 1dB-compression point or third-order intercept point specification. The maximum input level specification is the maximum input level that will not *damage* the attenuator or mixer. The 1dB-compression point or third-order intercept point refers to distortion caused by excessive input levels. The third-order intercept point ususally occurs about 10dB–15dB above the 1dB-compression point. If an analyzer specifies the 1dB-compression point as 0dBm, then input levels higher than 0dBm should not be present at the output of the RF attenuator. If the RF attenuation is set for 20dB, then the input level (at the input connector) may be as high as +20dBm without exceeding the 1dB-compression point. It is always best to allow an extra few decibels of safety margin. For example, if the 1dB-compression point is 0dBm, then the input level should be kept several decibels below this point for best performance.

Refer to the block diagram in Figure 1 above left. A *power pad* is used to limit the transmitter output to a level that the spectrum analyzer input can safely handle. Suppose that the spectrum analyzer has a maximum input rating of +30dBm and a 1dB-compression point of 0dBm. Further suppose that the transmitter output is 100W or 50dBm. If the power pad between the transmitter output and the spectrum analyzer input is rated at 20dB attenuation, then the RF level at the spectrum analyzer input will be equal to the rated maximum input level. A 30dB power pad would provide a 10dB margin of safety.

Suppose that the dynamic range of the spectrum analyzer is 70dB. This means that we can measure the level of the two signals on the spectrum analyzer as long as the difference in level between the two signals is less than 70dB. Also, the larger signal should be kept a few decibels below the 1dB-compression point of the spectrum analyzer.

As an example, suppose we wish to

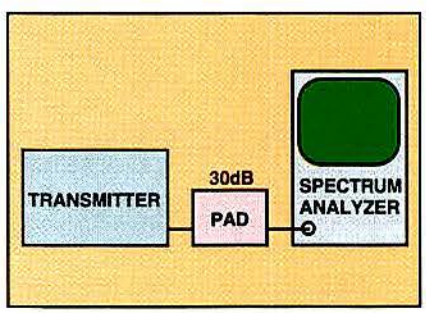

Figure 1. This test setup is used to set the 0dB reference level for following test procedures.

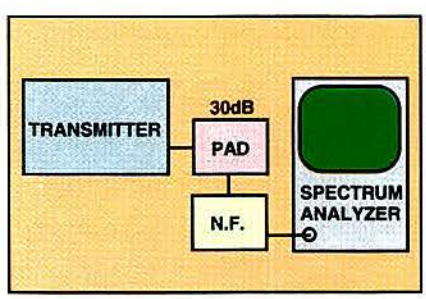

Figure 2. A notch filter can be used as shown here to effectively increase the dynamic range of the spectrum analyzer.

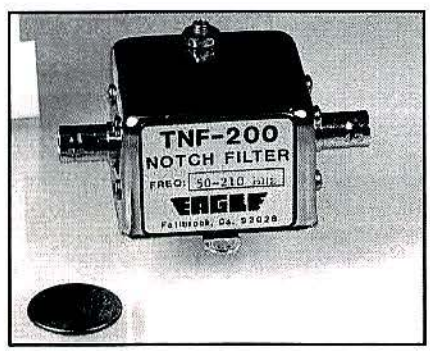

Photo 1. A tunable notch filter for use in making harmonic measurements with the spectrum analyzer is shown here. *Photo courtesy of Eagle, Sedona, AZ.*

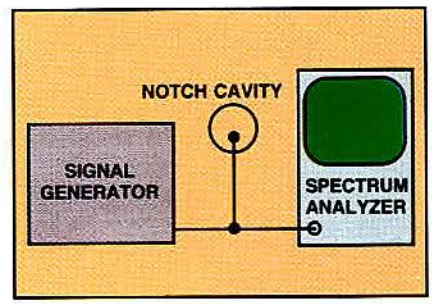

Figure 3. Here, a cavity notch filter is used to notch out the carrier frequency while passing the harmonic frequency with little attenuation.

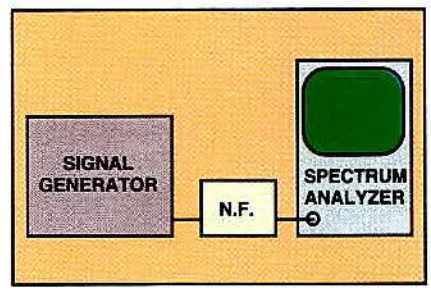

Figure 4. Here, a small "canned" tunable-notch LC filter is used to notch out the carrier frequency while passing the harmonic frequency.

Kinley, a certified electronics technician, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is a member of the Radio Club of America. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques,* which is available for direct purchase. Write to 204 Tanglewylde Drive, Spartanburg, SC 29301.

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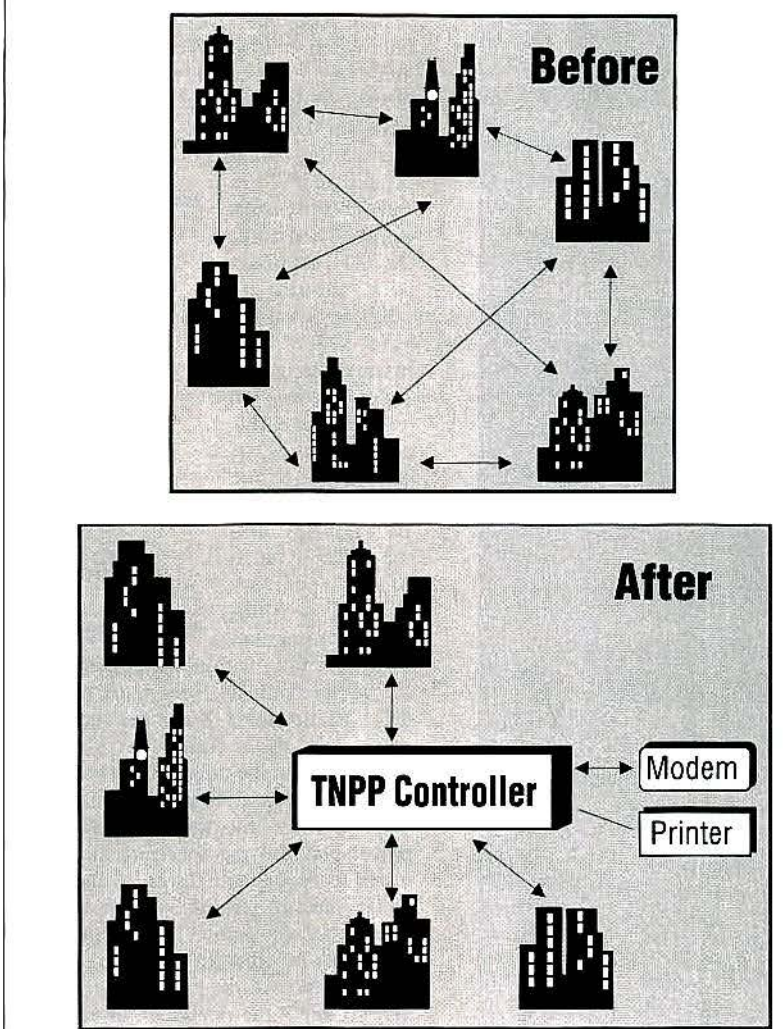

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measure the level of the second harmonic of the transmitter relative to the carrier. There are several things that we must consider in setting up to make this measurement. One is the 1dB-compression point of the spectrum analyzer. Another is the dynamic range of the analzyer.

Assuming a 30dB power pad is used, the setup shown in Figure 1 will limit the input to the spectrum analyzer to +20dB. This is 10dB below the maximum input level, so we are safe here. Suppose the second harmonic level is −80dBc (80dB below carrier level). To set the spectrum analyzer reference level to the carrier would require a reference level of +20dBm, but the input level without RF attenuation should not exceed 0dBm to remain below the 1dB-compression point. Therefore, the *RF attenuation* should be 30dB to be on the safe side. This brings the input level down to −10dBm at a reference level of +20dBm. Since the reference level is +20dBm and the dynamic range of the spectrum analyzer is 70dB, then the minimum level that falls within the dynamic range of the spectrum analyzer must be *above* the −50dBm level. Since the second harmonic is at the −60dBm level, it would not fall within the range of the instrument.

In order to keep our measurements as precise as possible, it is necessary to know the degree of insertion loss caused by the notch filter to the second harmonic signal.

To get around this problem, we can insert a filter into the line between the power pad and the spectrum analyzer in order to reduce the level of the carrier while causing minimal insertion loss to the second harmonic. (See Figure 2 on page 50.) In order to keep our measurements as precise as possible, it is necessary to know the degree of insertion loss caused by the notch filter to the second harmonic signal. The filter can be either a cavity type or a small LC filter in a metal "can." These are fairly small and more convenient than large cavities to use for such testing purposes. Usually, only 20dB–30dB of rejection is needed at the carrier frequency, so the small LC "canned" filters with tunable notches serve the purpose very well. Photo 1 on page 50 shows such a filter with BNC input/output connectors and the tuning adjustment to tune the notch within a broad range of frequencies.

Figures 3 and 4 on page 50 show the setup for determining the insertion loss of the filter to the second harmonic frequency. First, the signal generator and spectrum analyzer are set to the carrier frequency and the filter is tuned for maximum rejection of the carrier frequency as shown on the spectrum analyzer. Next, the signal generator is tuned to the second harmonic frequency (along with the specturm analyzer) and the generator level set to 0dBm. The insertion loss is now displayed on the spectrum analyzer. For example, if the spectrum analyzer display indicates −3dBm, then the insertion loss of the filter at the second harmonic frequency is 3dB. Make a note of this figure.

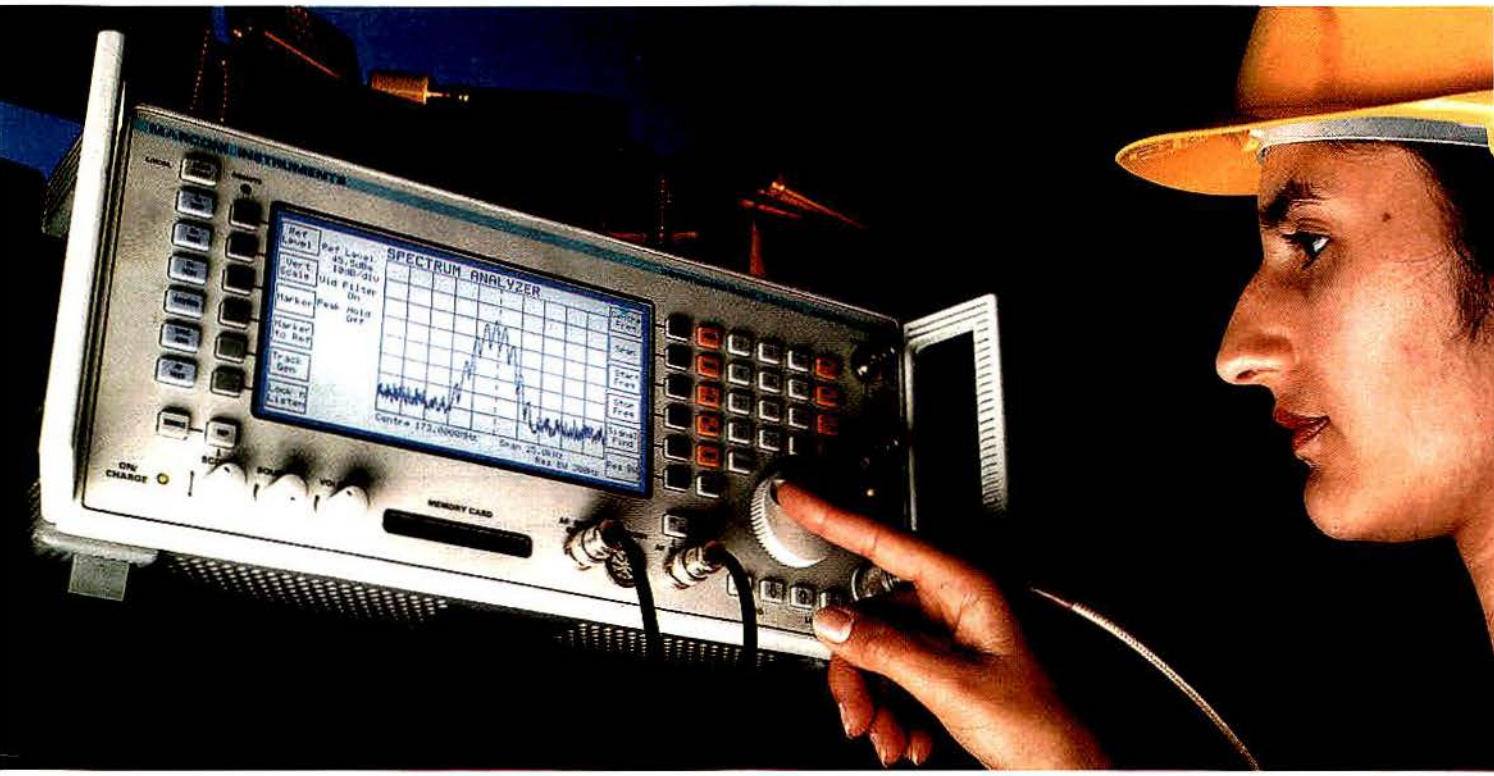
Now, using the setup shown in Figure 1, adjust the spectrum analyzer to produce a reference level of +20dBm with an RF attenuation of 30dB. This will keep the input level below the compression point.

Next, insert the notch filter (see Figure 2) and tune the notch filter for maximum rejection of the carrier. Now, increase the sensitivity of the spectrum analyzer by reducing the reference level and observe the level of the second harmonic signal. Suppose the second harmonic level is −60dBm and the insertion loss of the filter at the second harmonic frequency (as measured previously) was 3dB. Then, the actual level of the second harmonic is −60dBm −(−3dB) = −57dBm. Since the carrier level is +20dBm, the second harmonic is at a level of −77dBc (77 decibels below carrier).

The degree of accuracy obtained from the measurements above will be affected by the degree of shielding of cables, etc. The higher the attenuation of the power pad, the more likely it is that some stray RF paths will find a way around the attenuator, thus bypassing the test setup and invalidating the results. Use well-shielded interconnecting cables and keep the transmitter as far from the spectrum analyzer as possible. With reasonable care, you should be able to achieve very accurate results.

Until next time—*stay tuned!*

TestMate.



The new **Marconi 2945 TestMate**; the lightest, fully featured, radio test set available.

No matter what size your business, the new Marconi TestMate radio service monitor is the perfect partner. At just 11.4kg (25lb), TestMate is a complete bench of instruments in a single lightweight unit.

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A fast bright display update allows adjustments to be made with 'live' signals while a perfect combination of soft and hard keys provides flexibility and instant access to all functions.

TestMate makes cellular testing faster than ever and its rugged design makes it best for field tests as well as in the workshop.

Naturally the lightest, fully featured radio test set available is backed up by the best service support. For more about TestMate contact your local Marconi Instrument office.

Marconi
Instruments

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Product/Logo Directory

For more information on the products and services offered by the following advertisers in this issue, circle the corresponding number on the Fast Fact Card on page 105.

ADVANCED TECHCOM, INC.

Advanced Techcom

ATI designs, manufactures and markets high-technology digital microwave and millimeter-wave radios for point-to-point transmission of data and voice. The company, which targets backbone telecom to wireless (PCS/PCN) and cellular markets, offers a broad range of data rates and operating frequencies.

Circle (301) on Fast Fact Card

Allen Telecom Group

Allen Telecom Group produces base station equipment, including amplifiers, antenna systems, duplexers and multiplexers; signal coverage expanders, including boosters, microcell systems and repeaters; wireless measurement instruments; land mobile, cellular and PCS antennas and systems integration.

Circle (302) on Fast Fact Card

Anritsu Wiltron

Site Master, the new portable SWR/return loss analyzer from Anritsu Wiltron, measures SWR, return loss and distance-to-fault on analog and digital RF transmission lines.

Circle (303) on Fast Fact Card

A.P.E. South

The SMD-1000 Chipmaster radio and pager repair system provides low-temperature, high-power rework of all cellular and pager products, enabling controlled removal and replacement of all components.

Circle (304) on Fast Fact Card

Avtec

DSPatch & DSPatch32 are digitally switched integrated radio/telephone console systems with color touchscreen or mouse operation. Used by railroads, transit authorities and airlines, the consoles are designed for applications for public safety, utilities, military and other government agencies worldwide.

Circle (305) on Fast Fact Card

Bird Electronic

Wireless professionals depend on Bird instruments to measure or terminate RF energy. Products include renowned Thruline wattmeters, state-of-the-art antenna testers, load resistors, attenuators and accessories.

Circle (306) on Fast Fact Card

B+K Precision

B+K Precision's model 1670 triple-output power supply is designed for applications in the servicing market where multiple outputs are required. Capabilities include tight regulation, low ripple and separate digital LCD current and voltage meters.

(Circle 307) on Fast Fact Card

BK Radio

BK Radio designs, manufactures and sells two-way Bendix/King land mobile FM radio equipment. Products include VHF and UHF portables and mobiles, dual-transceiver mobiles, signaling devices and accessories.

Circle (308) on Fast Fact Card

Celwave

The Micro-BDA is available for both cellular and SMR applications, improving service in isolated areas. The 48610 and 48620 models offer high performance in a reliable, low-cost package. Both are FCC type-accepted and DOC-certified for 800MHz and 900MHz SMR/public bands.

Circle (309) on Fast Fact Card

Centurion International

Antennas and batteries for mobile communications, LMR, cellular, PCN, PCS, PCMCIA and other wireless applications. Engineering and Design department available to assist with custom antennas and/or batteries.

Circle (310) on Fast Fact Card

David Clark Company

Noise-attenuating headsets, radio adapters and accessories for two-way radios. Systems solve communication problems and provide hearing protection in high-noise areas. Adapters are available for all two-way radios. No radio modifications are required.

Circle (311) on Fast Fact Card

To Secure Your Future in NPCS Paging, Depend on Our Past.

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If you are in the wireless messaging industry, you know how important it is to evolve with technology. That is why Glenayre invites you to put our history of success to work for your future. Throughout the years, we have consistently delivered the infrastructure developments needed to advance your business.

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FLEX is a trademark of Motorola, Inc.

Circle (46) on Fast Fact Card

Product/Logo Directory

Communications Specialists

Manufacturer of encoders and decoders in CTCSS, DCS, two-tone sequential, shared repeater tone panel, Morse station ID and chip resistor/capacitor prototyping kits.

Circle (312) on Fast Fact Card

Connect Systems

Connect Systems, now in our 15th year of manufacturing for the communications industry, introduces a new line of logic trunking repeater controllers. Contact CSI for complete details of UHF LTR trunking.

Circle (313) on Fast Fact Card

Corp Ten International

Offers a complete line of automatic vehicle tracking systems (AVL) used for tracking vehicles and also boats/vessels. Hardware and software is provided.

Circle (314) on Fast Fact Card

CPI Communications

The MCR Alpha series remotes provide remote control of Motorola's Maxtrac, Radius GM300, Kenwood TK630/730/830 and Midland's Syn-Tech XTR radios. The remotes display channel number and user-programmable name.

Circle (315) on Fast Fact Card

CTI Products

CTI Products manufactures remote display and control equipment for receiver voting systems. It also makes transmitter steering controllers that work with comparators (voters) to steer multiple transmitters.

Circle (316) on Fast Fact Card

Cushcraft/Signals

Cushcraft PC-series of welded yagis is now available at new lower prices. These time-proven products eliminate service calls because of their welded construction and sealed-feed systems. PC yagis are available in many models for UHF, 800MHz/900MHz, PCS/PCN and 2.4GHz ISM band applications.

Circle (317) on Fast Fact Card

Daniels Electronics

Manufacturer of VHF-AM/VHF-FM/UHF/800MHz/900MHz radio modules for repeaters, rural telephones and ground-to-air systems. Modules are configured in subracks, transportable cases and portable cases.

Circle (318) on Fast Fact Card

Doppler Systems

Doppler Systems offers reasonably priced direction-finding systems covering 50MHz–1,000MHz. Users include cellular, two-way commercial radio and government.

Circle (319) on Fast Fact Card

DuraComm

Two-channel programmable tone and voice pagers in VHF, UHF and lowband. Switchmode power supplies from 7A to 75A, including 12Vdc, 24Vdc and 110Vac/220Vac switchable.

Circle (320) on Fast Fact Card

Eagle

Eagle supplies tunable notch filters for many communications applications. Our broadband filters are useful for making spectrum analyzer measurements, especially harmonic to −90dB. Other filters are useful to solve site interference problems. Contact us with your requirements.

Circle (321) on Fast Fact Card

Eagle Telecom International

Eagle Telecom International's line of paging products includes receivers, synthesized transmitters, solid-state power amplifiers, base stations, transmitter controllers and License Starter paging systems.

Circle (322) on Fast Fact Card

Gamber-Johnson

Gamber-Johnson makes the equipment you need to mount computers and radios into virtually any vehicle. Mounts are made of durable, heavy-gauge steel and come with a lifetime warranty.

Circle (323) on Fast Fact Card

Glenayre

Glenayre manufactures wireless messaging switches, controllers, transmitters and alpha dispatch systems for the radio paging industry. Its other products—voice processing, rural radio and microwave systems—serve a variety of markets

Circle (324) on Fast Fact Card

Hark Systems

Hark's TNPPEX network controller allows TNPP traffic to be routed to 32 ports. An optional statistics computer gathers information that is valuable for billing of resellers.

Circle (325) on Fast Fact Card

Photo courtesy of Rohn

CELLGUARD™

It's the next best thing to being there. All the time.

The Narda CELLGUARD 8450 from Lockheed Martin is the only cost-effective approach to accurate on-site monitoring. It gives the cellular, SMR and paging industries everything you've been looking for in remote site continuous power and VSWR monitoring and haven't been able to get until now.

- **Measures both transmitted and reflected power with guaranteed accuracy of ±0.1 dB over 600 mW to 600W CW dynamic range.**
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- **Accurately measures VSWR from 1.07 to 3.00 on a continuous range basis.**
- **Provides a form C relay alarm, responds to query, or transmits data continuously via internal microprocessor and RS485 bus control.**
- **Independent low power and software definable alarms.**

If the question is vandalism, storm damage, transmitting power, or equipment problems, the answer is CELLGUARD.

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Circle (48) on Fast Fact Card

Product/Logo Directory

Hustler

Hustler offers a complete line of single- and dual-polarized PCS panel antennas as well as base antennas for cellular, trunking, paging, UHF and VHF applications.

Circle (326) on Fast Fact Card

Hutton Communications

Wireless communications equipment and components from Hutton! As a regional distributor with national strength, Hutton can offer fast delivery, personal service and product delivery.

Circle (327) on Fast Fact Card

IDA

IDA is a world leader in design and manufacture of two-way radio remote controls. Models range from eight-line mini consoles and sophisticated trunking remotes to simple, cost-effective desk sets.

Circle (328) on Fast Fact Card

IFR Systems

IFR Systems designs, manufactures and markets communications service monitors, RF and microwave spectrum analyzers and avionics test equipment. The company also provides test equipment for fiber-optic systems.

Circle (329) on Fast Fact Card

Kenwood Communications

Kenwood Communications offers VHF and UHF trunked and conventional portable and mobile radios for business and government. Contact Kenwood and ask about the new TK-260/360 portable.

Circle (330) on Fast Fact Card

King Communications U.S.A.

King's KDT-5000 advanced mobile data system has an eight-line full graphics display and variable font sizes for display in any language. Features include OTA programming, trunking compatibility, 6,000bps data throughput (even at 12.5kHz spacing) and GPS capability.

Circle (331) on Fast Fact Card

Larsen Electronics

Larsen Electronics manufactures high-performance mobile, on-glass, portable and base station antennas. Larsen produces more than 1,000 antenna models from 27MHz to 2+GHz for the most-demanding international, commercial and amateur applications.

Circle (332) on Fast Fact Card

Macaw Electronics

Sector hand-held transceivers use interchangeable parts with modern microprocessor and synthesizer circuitry. Built using state-of-the-art surface-mount technology with the performance of more expensive radios in a compact, rugged, cost-effective package.

Circle (333) on Fast Fact Card

Marconi Instruments

Marconi provides electronic instruments for research and development, manufacturing, installation and maintenance of communications systems. Products include analog and digital radio communication test systems, microwave test systems, signal generators, telecom test sets and spectrum analyzers.

Circle (334) on Fast Fact Card

Maxon America

FM two-way communication equipment offered by Maxon includes synthesized VHF and UHF portable and mobile radios and crystal portable radios for VHF lowband, VHF highband and UHF. POCSAG numeric pagers, paging systems, data telemetry modules and SMR/trunking products.

Circle (335) on Fast Fact Card

Maxrad

Maxrad manufactures a complete line of antennas for land mobile, cellular, marine, global positioning, personal communications systems and base station applications in the frequency range from 27MHz to 2.4GHz. Additionally, it manufactures mobile, marine and base station mounting hardware and related accessory products.

Circle (336) on Fast Fact Card

Modular Communication Systems

Modular Communication Systems' consoles and stand-alone dispatcher workstations include the Ultra-Com PRO, which features "Screenmaker" and "Customizer" programs allowing the user to modify screens for specific requirements.

Circle (337) on Fast Fact Card

Motorola Communication Test Equipment

The new CyberTest system is a user-programmable wireless communications test platform that features an analyzer for test and measurement functions and a PC for overall control and Windows-based graphical interface. It works in the cellular and PCS bands.

Circle (338) on Fast Fact Card

PiRod

PiRod's "Tower Parts and Accessories" catalog is loaded with photos, drawings and descriptions to help you identify, specify and price the tower parts you need.

Circle (339) on Fast Fact Card

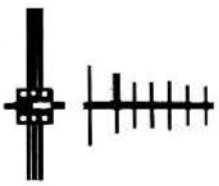
The Industry's

10 MOST WANTED

Considered Armed & Dangerously Affordable

Industry Top Ten Product

ANT940Y10-WR, also known as Yagi Antenna. born 6-24-74; 2.5 lbs; 24" x 9"; Known associates: likes to hang out in dingy, dismal areas. hvy bld; blk TXYLAN coated. Known to violently resist corrosive gases, ultraviolet radiation, salt spray and acid rain. Wanted for directional control.



PRINTS AVAILABLE

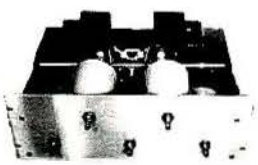
Industry Top Ten Product

TS4680, also known as Cross Band Coupler. born 2-10-86; size 6.6 x 1.5 x 0"; 1 lb; hvy const; 400 watts; blue finish; tower mountable. Wanted by tower operators for multiple transmissions of 450-860 equipment.

PRINTS AVAILABLE

Industry Top Ten Product

TC860, also known as Cellco Ceramic Trunking Combiner. born 5-25-91; size 7x19x14"; 36 lbs; rugged bld; 125 watts, alum finish. Wanted by SMR operators who want only the best.



PRINTS AVAILABLE

Industry Top Ten Product

ANT450D3, also known as Dipole Array Antenna. born 9-14-58; known associates: other antennas in other freq bands and gain. hvy bld; blk TXYLAN coated. Known to violently resist corrosive gases, ultraviolet radiation, salt spray and acid rain. Wanted by tower operators with the worst possible problems.

PRINTS AVAILABLE

Industry Top Ten Product

Model 44AP, also known as the Broadband RF Wattmeter. born 6-11-78; weight 4 lbs; rugged bld; 500 watts; gray comp; operates alone, no known associates; distinguishing marks: leather band on top, sample port right side. No known enemies, has been spotted worldwide.

R. Middle

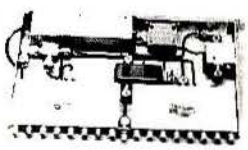
Industry Top Ten Product

PMU1C1S, also known as Power Monitor Unit. born 4-23-95; sml bld; blk, red eyes glow in dark. Wanted for monitoring ant VSWR and TX power. Notorious for working multiple freq in all bands. Known associates RS232 and RS485.

R. Index

Industry Top Ten Product

TWR816-860-1RTT, also known as Compact Receiver Panel. born 8-14-93; exceptional small build, likes to associate with multiple frequencies. Quiet 2.5 dB noise; modular; has been known to redundantly switch to 2nd channel if injured; likes living in harsh locations. Wanted for resisting interfering signals.

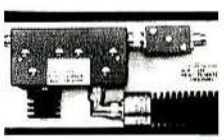


PRINTS AVAILABLE

Industry Top Ten Product

TS450PB1, also known as IM Suppression Panel. born 7-12-75; rugged bld; black & blue marks on body; 5 lbs; 19"x5.25"x1.50 w[illegible] dB; wanted by th[illegible] for killing intermodulation; likes isolation. Reward is offered for protectionism.

IM CAPTURED



PRINTS AVAILABLE

Industry Top Ten Product

PM5C1S, also known as Automatic Alarm Panel. born 2-23-81; brushed alum; 1.4 lbs; 19"x3.5"; Known associates: likes to snitch on bad trans & ant; needs to be placed inline; violently resists high VSWR; likes power. Do not approach, will call you.

PRINTS AVAILABLE

Industry Top Ten Product

TATC8944, also known as Cellular Auto Tune Ceramic Combiner. born 4-1-92; size 10.25W x 10.75H x 12.75"; 36 lbs; heavy bld; black finish; easy to install. Wanted by Cellular operators for retrofit or new installations, both in USA and foreign countries.

L Thumb

Call for information leading to the acquisition of these ten most wanted products:

1-800-331-3396

in USA and Canada

Circle (51) on Fast Fact Card

TELEWAVE, INC.

1155 Terra Bella • Mountain View, CA 94043
(415) 968-4400 • Fax (415) 968-1741

Product/Logo Directory

PolyPhaser

PolyPhaser designs and manufactures lightning/EMP and grounding for coax, power and twisted pair protectors. Custom products, training, testing and consulting services are available.

Circle (340) on Fast Fact Card

Ritron

Located in Carmel, IN, Ritron designs, manufactures and markets RF wireless voice and data communications products. Products include low-cost, rugged, crystal-controlled Jobcom portable radios; Patriot high-performance, synthesized, programmable portable and mobile radios and repeaters; data transceivers; RF telemetry systems and wireless phone line extender systems.

Circle (341) on Fast Fact Card

Selectone

With over 15 years serving the wireless communications industry, the "new" Selectone manufactures voice encryption, CTCSS, DTMF, ANI, data messenger systems and other exciting products.

Circle (342) on Fast Fact Card

Standard Communications

The 15W GX5850T trunked mobile operates on 900MHz LTR and conventional protocols; features 20 systems/200 groups; 100-channel conventional capabilities; five user-programmable function keys; dot-matrix display; interface for AVL, MDT, remotes; MIL SPEC 810-C, D and E for shock and vibration, and three-year warranty.

Circle (343) on Fast Fact Card

STI-CO Industries

Since 1967, STI-CO has manufactured custom-disguised mobile two-way antennas, including exact AM/FM antenna replacements and a variety of cellular look-alike models in all frequencies.

Circle (344) on Fast Fact Card

Tait Electronics-USA

An international company specializing in the design, manufacture and distribution of a wide range of two-way mobile communications systems and products in the 66MHz–960MHz frequency range.

Circle (345) on Fast Fact Card

Telewave

Introduced at IWCE '96, the Telewave TATC-8945 Auto-tune Trunking Combiner is our latest full-power, rack-mount system solution. Contact Telewave with your system requirements.

Circle (346) on Fast Fact Card

TESSCO

Tessco is a leading global supplier to the cellular telephone, paging, PCS and mobile radio-dispatch markets providing express delivery of 14,000+ products from over 230 manufacturers. Contact us for a complimentary buyer's guide and other valuable wireless business tools.

See ads on pages 21, 22

Transcrypt International

The DME 9600 dual-mode encryptor provides digital encryption and analog voice privacy over PSTN. The unit is backward-compatible with our analog cellular and landline voice privacy products and plugs between the handset and base of any office phone, preserving proprietary features.

(Circle 348 on Fast Fact Card)

TX RX Systems

TX RX Systems is widely recognized for quality, reliability and performance. Our product line includes multicoupler systems, signal booster systems, duplexers, cavity filters and RF system products.

Circle (349) on Fast Fact Card

Vega

Vega's new C-6024 Multiline desktop console can accommodate both dedicated leased circuits and telephone lines. The C-6024 is expandable to 24 lines and comes with a touchscreen display.

Circle (350) on Fast Fact Card

VoCom Products

VoCom Products designs and manufactures RF power amplifiers. It offers linear A and AB amplifiers for the PCS and cellular markets, and class C amplifiers for the trunking, paging and two-way radio markets.

Circle (351) on Fast Fact Card

W & W Associates

W & W Associates is a U.S. manufacturer of replacement batteries and chargers/analyzers for two-way radios, cellular phones, camcorders and biomedical equipment.

Circle (352) on Fast Fact Card

Zetron

Easy-to-use ULTRAc wireless SCADA and telemetry systems feature PC-based centrals; use of existing radio systems; NEMA cases with battery backup; PLC monitor and control systems; PLC communication via MODBUS; and voice and paging alarms over phone or radio via SentriVoice and SentriDial product lines.

Circle (353) on Fast Fact Card

HOSPITALS LAW ENFORCEMENT EMERGENCY SERVICES CRITICAL EMERGENCY UTILITIES SECURITY DISPATCH

If communication is vital to your operations, then you understand that equipment must be both versatile and easy-to-use. Even more importantly, it must be as reliable as the foundation under your building.

Zetron's Digital Tone Remotes have quickly become the preferred radio controllers for critical applications.

Versatility is maximized with a built-in paging encoder and a PC-programmable feature set. **Ease-of-use** is guaranteed by a text display that shows the formal name ("Police," "Ambulance," "Line Crew," etc.) for every frequency or pager code entered by the dispatcher.

But most importantly, the remotes are from Zetron. This means **reliability** that is backed up by the industry's best warranty and technical support.

If you are in the business of supporting critical communications, call Zetron today for more information on the Model 260 and Model 280 Tone Remotes.

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A closet full of memories

By Robert H. Schwaninger Jr.

The other day one of my associates was rooting through a closet in our offices looking for some obscure supplies. This particular closet is darkly tucked in a corner of the offices to offset an inexact floor plan. The closet's contents are often forgotten, yet it is the natural vortex into which all things unnecessary, but seemingly precious, seem to flow—like a woman's purse. So, it was the natural resting spot of a well-preserved copy of an industry magazine dated December 1986 that had fallen unceremoniously behind some shelves.

"WELCOME ABOARD, CAPTAIN FOGSANER, ADMIRAL O'BRIEN IS ON THE BRIDGE."

Although the discovery of the magazine didn't cause the same stir as the Dead Sea Scrolls, the contents of the magazine provided an interesting perspective. I was on the scene in '86 and had begun my deep involvement in the changing regulatory environment. But at the time, I didn't fully recognize the watershed events that were occurring in that year.

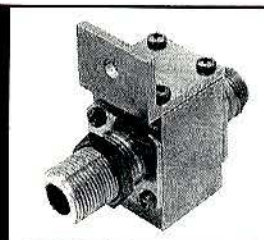
In 1986, the FCC completed its last significant Report and Order in Docket 83-737, that created the monopoly frequency coordination system. Although the system has been criticized and challenged, it has endured for these ten years and has created a new strata of power brokers in telecommunications regulation. Well-known and respected before the Order was released, Mark Crosby and Jay Kitchen would become more than servants of industry associations. They often came to symbolize the competitive struggle to redefine the direction of regulation, sometime as zealots and often as steadying, paternal figures.

Jay Kitchen was quoted in the magazine on an issue that was in its infancy ten years ago, auctions of radio spectrum. Responding to Chairman Mark Fowler's support of auctions, then NABER President Kitchen said, "Let the industry message be clear. We do not want auctions and we do not want a modified form of auctions which seems to be the basis of today's proposal by the FCC."

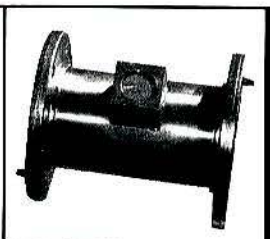
In that year, the commission was still

Schwaninger, *MRT*'s regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC. He is a member of the Radio Club of America.

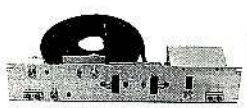
Grounding & Lightning Protection Solutions



DC BLOCKED 1.5MHz TO MICROWAVE 20GHz

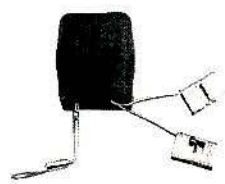


BROADCAST & MILITARY TO 80 kW

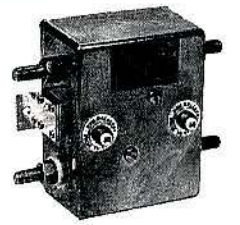


RACK PANEL PROTECTOR 120/240Vac, 15-20A

UNI-KIT COAX CABLE GROUNDING



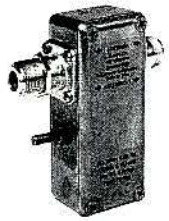
DATA/PHONE PUNCH DOWN BLOCK



SOLAR/BATTERY

PHONE LINE/LAN/T-1

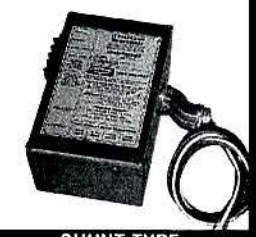
POWER PROTECTOR 120/240Vac,15-20A



1.2 TO 20GHz MICROWAVE & DOWNCONVERTERS

IN-LINE POWER MAINS

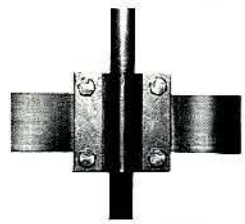
COAX PROTECTOR WITH SAMPLER PORT



SHUNT-TYPE POWER MAINS

CELLULAR PROTECTORS TO 980MHz

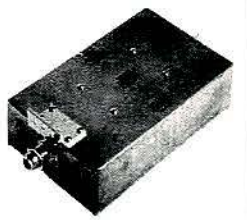
STRIKE COUNTERS TOWER/POWER/PHONE



GROUNDING COMPONENTS

LAN/VIDEO

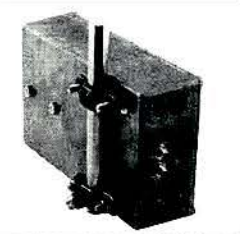
GLOBAL POSITIONING SYSTEM (GPS)



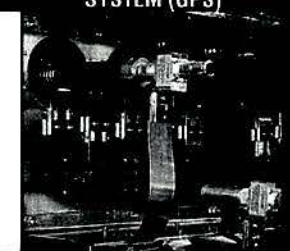
UHF COMBINERS

POWER SUPPLY PROTECTOR

COPPER CLEANING KIT (CCK)



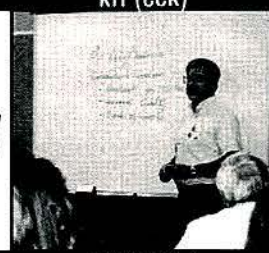
TVRO PROTECTOR LNB & MOTOR CONTROL



COAX ENTRANCE PANELS

CONSULTING

VIDEO & TUTORIAL BOOK



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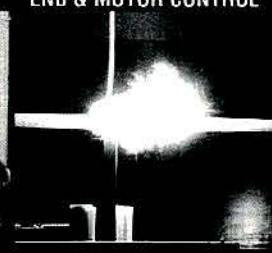

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groping with ways to deal with the exploding land mobile industry. Resellers were becoming rich behemoths of entrepreneurial vim. SMR operators were growing in number and profitability. IMTS began its decline with the advent of greater uses of trunking technology. Paging had not yet found the average consumer's ear, but was standing on the brink of its greatest marketing explosion. Private carrier two-way systems simply didn't exist.

In the summer of 1986, the FCC reaffirmed a 1984 decision to deny the allocation of 900MHz spectrum reserve to create a new private radio service. Managing Director, Edward Minkel, penned an open letter that requested suggestions for making the commission more efficient, including privatizing more functions. The magazine announced that CTIA would hold its first annual meeting in Phoenix, AZ, in early 1987.

The classified ads were filled with dated goods and services. Pro-Tec Mobile Communications of Casa Grande, AZ, was touting "Expert Pulsar Service Repair"; R. W. Brown Electronics of Sycamore, IL, was selling "Horn Honk Kits"; Hank Frank was trying to buy Motorola Reeds and Channel Elements; and a full-page ad hawked a new 900MHz pager from Kokusai Electric Company. *Who?*

In 1986, Mark Fowler was Chairman of the FCC and Bob Foosaner was stepping down and out as Chief of the Private Radio Bureau. Foosaner accepted a job with the law firm of Jones, Day, Reavis and Pogue, the shop that Morgan O'Brien called home. So it was no surprise that Bob Foosaner would eventually follow O'Brien to Nextel. In fact, these three men, Foosaner, O'Brien and Fowler, would see a lot of one another over the next ten years, each adding to the other's success in private industry. Through them the ESMR industry was created and became the force it is today.

At the time of the departure, the magazine editor wrote of Foosaner, "Washington is a tough town to keep your virtue in. For many, straightforwardness is the name of the game until personal advantage dictates otherwise. Fortunately, that's a game Mr. Foosaner has refused to play and this industry has been the better for it." In 1986 competing opinions could only be found in an outlaw publication called "The Rattler," penned by Merrill T. See of Kalamazoo, MI.

Amid all of the news and changes of 1986, there was a sense that the industry was losing its innocence.

The magazine described the events of the latest IWCE Show, including the capturing of the grand door prize by David Fountain of LaGrange, GA; a picture of George McClelland watching the events; and quotes from Ray Russenberger, owner of Network Paging Corp. of Lafayette, LA, which became Network USA of Florida which was sold recently to A+ Communications which will become...who knows?

Amid all of the news and changes of 1986, there was a sense that the industry was losing its innocence. Resellers in large

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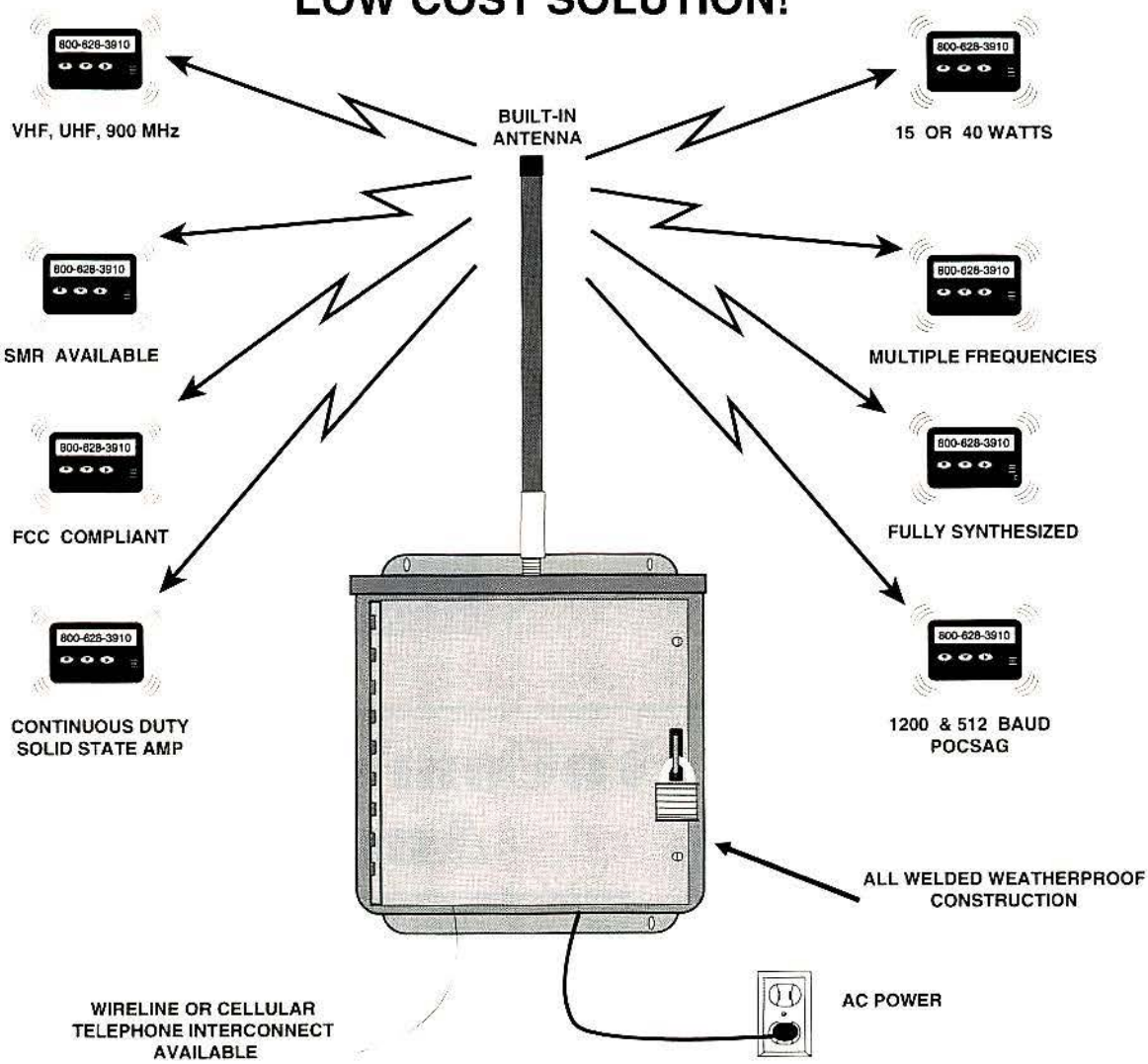

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urban markets were suffering their first setbacks from new terms on renegotiated contracts with cellular carriers (remember residual payments on billing?). Huge paging companies, like PageNet and Pagemart, were beginning their meteoric rise to the top of the heap, propelled by the lowest paging prices in the industry. Motorola was redefining its place, starting to reduce its direct market presence and focus more on manufacturing and technology, while maintaining and increasing its grip on thousands of SMR licenses.

1986 would mark the year when the term "application mill" entered the general lexicon of industry buzz words. Programmable radios were quietly becoming the norm, while Congress made sure that scanners skipped the cellular radio band by adopting the new Privacy Act. ACSB was a flop at 150MHz and wouldn't emerge again until given regulatory CPR at 220MHz–222MHz, with a flurry of lottery ticket applications that provided more ammunition for proponents of auctions.

Meanwhile, another seemingly unimportant event was taking place. On June 1, 1986, a new law firm was created. Just two guys with an idea that maybe they would do things a little differently than everybody else—a little bolder with a bit more volume and panache. On that day in 1986, the firm of Brown and Schwaninger was formed with no money, no clients, and more time than good sense. Since then, the firm has been called by an FCC official, "the most humorous, colorful and zealous firm" in telecommunications law. An industry spokesperson recently said, "they are the biggest thorn in the FCC's side, but that's not bad."

On this, the tenth anniversary of our firm, I wish to thank the hundreds of clients who have come to us over the years. I also want to thank all of the FCC employees who have wrestled with us over many an issue and made life more interesting. Remember, Terry, Roz, Riley, Kathy, Bill, Gary and Ralph, it was and is just business. Finally, I want to thank Don Bishop, *MRT* and Intertec Publishing for giving my voice a home when other magazines thought my ideas were too controversial—like *Communications*, the now-defunct periodical whose pages I scanned in writing this column.

Over the next ten years, I'll still call it the way I see it, even if its not always the politic thing to do. I'll poke fun at the FCC, even if they sometimes don't think I'm funny. I'll still promote honest competition, the American Dream, and "hell no" tactics. If I'm still writing this column in 2006, I hope that I find that the candle I kept burning wasn't used to lead the industry down another blind alley.

Telecom Towers acquires Ram Communications Consultants

Telecom Towers, Arlington, VA, has acquired Ram Communications Consultants, Woodbridge, NJ, from RAM/BSE Communications, the partnership of Ram Broadcasting and BellSouth Enterprises. The new Telecom Towers subsidiary will continue to operate out of Woodbridge under the name RCC Consultants. Telecom Towers will also acquire the communications facilities management business from the RAM/BSE partnership. This business added to Telecom's facilities will give Telecom 500 sites throughout the United States.

E.F. Johnson establishes Communication Services Division

E.F. Johnson, Burnsville, MD, has formed E.F. Johnson Services, a wholly owned division that will offer a variety of communications facility installation and construction-related services. Target markets include the emerging personal communication service (PCS) industry, as well as cellular telephone providers, specialized mobile radio (SMR) operators and other communication industry participants.

Geotek launches South Florida digital wireless comm network

Geotek Communications, Montvale, NJ, has begun offering services to the Miami, Fort Lauderdale and Palm Beach markets in Florida. The network is designed to provide integrated voice and data communications to businesses that manage a mobile workforce. The network provides information to mobile workers through Geotek's Mobile Workstation, which combines the functions of a cellular phone, two-way radio, pager and laptop computer.

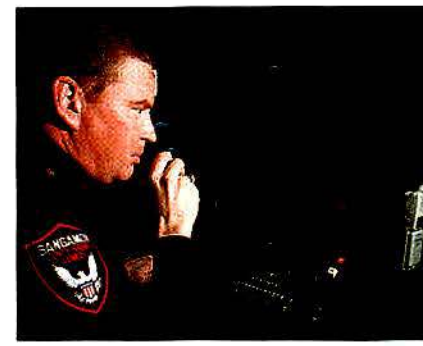
The start-up of the South Florida network is part of Geotek's nationwide network rollout. The company has commercial networks operating in New York, Philadelphia, Washington-Baltimore and Boston and will offer service in Dallas later this spring.

Bird announces winners in contest to locate oldest Thruline wattmeter

Bird Electronic, Solon, OH, revealed 11 winners in Quest 43, a year-long contest to locate the oldest working model 43 Thruline wattmeter. The announcement of the grand prize winner, Justin Dennis, was made at the IWCE show in Las Vegas. Dennis's wattmeter, serial No. 71, was produced in 1952 and is still operational. Dennis was presented with a 24-kt gold-plated Model 43, a $1,000 gift certificate and a new model 43. Dennis plans to donate his vintage unit to Bird for permanent display in the Solon facility.

First prize ($500 gift certificate and a new model 43) went to Bernie Wendoloski for his model 43 with serial No. 76. Eight other owners whose wattmeters were manufactured in Bird's first production run in 1952 were awarded $250 gift certificates and a new Model 43.

Domestic violence alarm links to police cars in Sangamon County, IL



Deputy Patrick L. Davlin of the Sangamon County Sheriff's Department in Springfield, IL, demonstrates how signals from domestic violence alarms will appear on computer terminals mounted in squad cars. *Photo courtesy of HTE, Orlando, FL.*

Victims of domestic violence in Sangamon County, IL, now have access to "domestic alarms" that are linked to computer terminals in the county's police cars. The alarm is activated by a device that can be worn or kept in a purse. Police will be alerted almost immediately on computer terminals mounted in their squad cars. Not only is response time cut, but police are better prepared to deal with the incident once they arrive because they can use their terminals to access information about the victim's situation while they are responding to the call.

HTE, Orlando, FL, provided the special interface, along with the consulting services, system modifications and some of the hardware that was required to connect the devices and squad-car-terminal systems.

Cerulean Technology wins contract from city of Worcester, MA

Cerulean Technology, Marlborough, MA, formerly PacketCluster Systems, has been awarded a contract by the city of Worcester, MA, to install its PacketCluster software in 25 of the city's patrol cars. The software is designed to transmit information through the Ericsson EDACS radio network installed last year.

Trial to test locating service for cellular callers

The Associated Group, Bala Cynwyd, PA, and Comcast Cellular Communications, Wayne PA, plan to launch a trial this summer of a new cellular feature called TruePosition Cellular Location System. The trial will span a 50-mile stretch of the New Jersey Turnpike to test the effectiveness of Associated's technology in locating cellular callers.

Simmonds announces sale of Midland distribution businesses

Concurrent with the May 21 announcement of its 1995 financial results, Simmonds Capital Limited, Willowdale, Ontario, Canada, announced that the company will sell its remaining Midland distribution businesses. The U.S. distribution business of Midland International, based in Kansas City, MO, is to be combined with Securicor Radiocoms, Surrey, England, and the Roamer One airtime services business owned by Intek Diversified, Torrance, CA, under a previous agreement. Securicor Radiocom's parent, Securicor Group, Surrey, England, will have a controlling interest in the combined business, with Simmonds owning a minority interest.

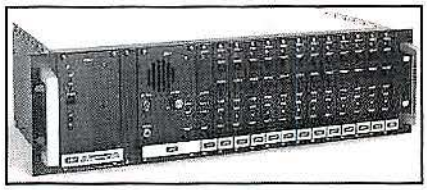
Simmonds will continue to participate in the wireless communications business through Midland Systems (also known as SCL Systems), Pickering, Ontario, Canada, and through minority investments in other wireless companies.

The 1995 financial results indicate a net loss for Simmonds of $9,318,000 on sales of $94,145,000 (Canadian). "While we are disappointed with the results for 1995," said John Simmonds, the company's chief executive officer, "we remain optimistic about the significant potential and the value in our electronics businesses and the opportunities in the wireless communications market."

Trump Plaza selects Ericsson's EDACS to facilitate communications

Atlantic City-based Trump Plaza Hotels and Casinos have chosen to implement Ericsson's, Lynchburg, VA, digitally trunked technology and provide radio communications coverage for its three buildings. The casinos will use 350 Ericsson M-RK 900MHz portable radios. Primary users will be security personnel, although 10 departments will have access to the system. The system will eventually interface with the Slot Data Computer Monitoring System (SDCMS), which gives information on the location of winners and disturbances. With the Ericsson System, a message will be displayed on the face of the radio, allowing security personnel to respond more quickly to emergency situations.

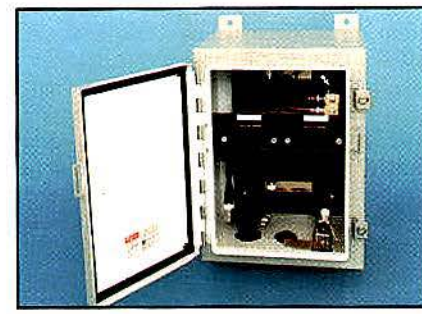
SNR voter makes continous digital selection from multiple remote sites



The SNV-12 voter from **JPS Communications** uses separate digital signal processors to continuously select the receiver with the best signal-to-noise ratio (SNR) from multiple remote sites. Signal is measured in the 300Hz–800Hz band by a JPS proprietary speech detection and measurement algorithm. Noise is measured in the band above 2,200Hz. The SNR measurement operates from −6dB to +36dB in 1.4dB steps.

Circle (401) on Fast Fact Card

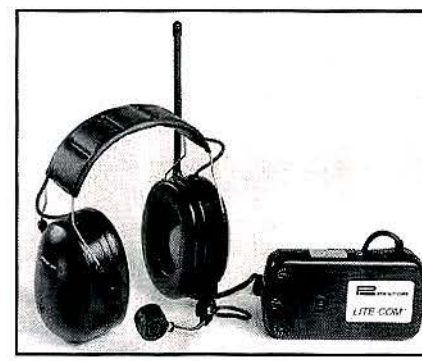
Tower top amplifiers boost power, increase received signal clarity



The DB8980 series of base station tower top amplifiers is designed for use in cellular and 800MHz SMR trunked systems. The amplifiers from the **Decibel Products** division of Allen Telecom Group are based on gallium-arsenide field-effect transistor (GaAsFET) chip-based modules to improve gain and sensitivity in base station receivers. The amplifiers are designed to lower the system noise figure to improve system sensitivity and to eliminate transmission line signal loss by placing preamplifiers at the base of a receiving antenna. The reduced output power requirement for transmitting mobiles or phones equipped with dynamic power control increases battery life and the mobile unit's range.

Circle (402) on Fast Fact Card

Lightweight headset provides wireless in high-noise areas



The Lite-Com from **Peltor** is a compact, portable, five-channel, two-way FM transceiver offering a choice of hands-free or PTT operation. The noise-attenuating headset comes with a whip antenna and a noise-canceling boom mic. A throat mic option is available for use in high-ambient noise situations or with full-face protective gear. The simplex system has a quarter-mile range and features an LED low-battery indicator, channel selector and battery charger jack.

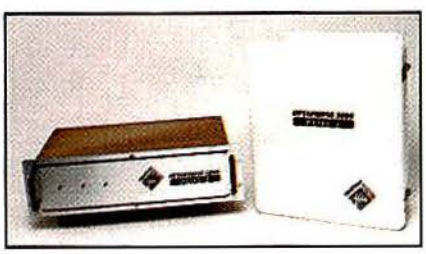
Circle (403) on Fast Fact Card

Waveguide dehydrator furnishes automatically regenerated dry air

Environmental Technology's ADH-3COM computerized air dehydrator features automatic regeneration. The unit provides low-pressure dry air required in satellite earth stations and general-purpose microwave applications. Operation is user-selectable at 120V or 230V 50Hz/60Hz, with a maximum power consumption of 146W only during regeneration. Average power consumption does not exceed 60W. With a 5.25" panel height, the dehydrator mounts in a standard 19" relay rack. Features include LED display for status and operational information, and dual compressors for improved reliability and greater air flow. Low-pressure and high-humidity alarm relays are standard, and all operational parameters can be monitored remotely through a RS-485 serial port. Standard discharge pressure is 0.5psig, with 3psig or 6psig optional.

Circle (404) on Fast Fact Card

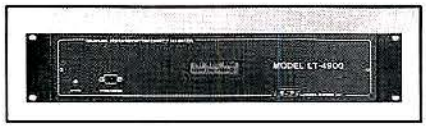
Phone system provides voice, data from narrowband FM channel



The OptaPhone 2000 Plus-2 from **OptaPhone Systems** is a wireless, dual-channel telephone system employing a single, digitally controlled, narrowband FM radio channel to provide two voice and data channels. Data rates as fast as 14.4kbps are supported. Features include surface-mount technology, simple installation and remote diagnostics. The system is available in programmable VHF and UHF frequency bands of 144MHz–174MHz, 403MHz–430MHz and 450MHz–470MHz, and is fully integrated with OptaPhone's multi-access wireless systems.

Circle (405) on Fast Fact Card

Repeater manager with interconnect matches Johnson, Uniden busses



The model LT-4900 from **Connect Systems** is an LTR trunking repeater manager with interconnect designed to be fully compatible with the E.F. Johnson and Uniden repeater busses. The control panel features an LCD for current user ID, repeater status, help data and programming details. The unit allows networking using intersite speed dialing, call forwarding to user-definable sites, recognition of roaming mobiles and wide area multiple site dispatching.

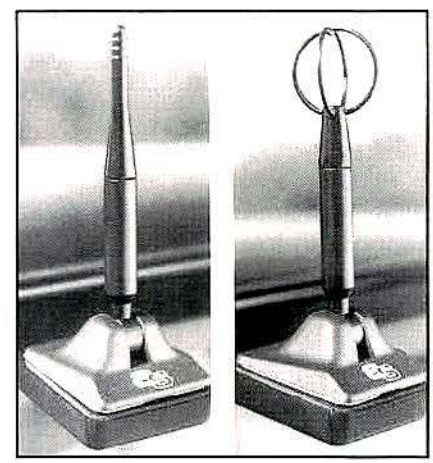
Circle (406) on Fast Fact Card

PC-programmable mobile radios offer choice of 4, 24, 100 channels

Tait Electronics' T2000 series of PC-programmable, clonable mobiles are available in four-, 24- and 100-channel models. VHF models can be programmed to operate from 136MHz to 174MHz without retuning, as can UHF models, from 400MHz to 470MHz, or from 450MHz to 520MHz. RF power output is 25W at these ranges, higher for smaller frequency spreads. Standard features include programmable CTCSS/DCS, time-out timer, fast scan and busy-channel lockout.

Circle (407) on Fast Fact Card

Globe and spike antennas combine solid-state design, aerodynamics



The **Antenna Specialists** division of Allen Telecom Group has combined its patented glass-mount mobile antenna technology and solid-state engineering techniques with European antenna designs to produce the On-Glass Globe and On-Glass Spike mobile cellular antennas. The low-profile, unity-gain antennas offer minimal wind resistance and noise due to aerodynamic design and a height of only 3". Both models have a solid-state coupling box that allows the antennas to achieve a typical VSWR of 1.9:1. The coupling box, pretuned at the factory, channels RF energy transfer between the window defogger wires to the antenna, to minimize signal loss and maximize coverage.

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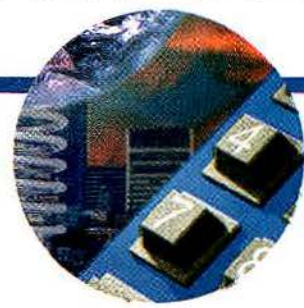

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Readers' choice

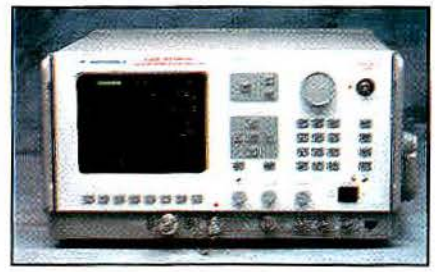
Of all the new products and services in the November 1995 issue, the one reprinted here generated the most reader requests for additional information. If you missed it the first time, here is your opportunity to acquire more information on it. Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

Hand-held transceiver includes 5W RF output on 10 channels

The MicroTalk hand-held two-way radio includes 5W RF output on 10 synthesized channels with multiple CTCSS tones and user-selectable scan to lock out or avoid busy channels. The back light for the LCD turns off automatically to reduce power consumption. Available in VHF and UHF models, the transceiver comes with a belt clip, a 600mAh battery, a 110V wall charger, a rubber duck antenna and a wrist wrap. **Global Wireless Communications Products** supplies the transceiver to end-users, and **Advanced VideoTech** supplies the transceiver to dealers.

End users,
Circle (500) on Fast Fact Card
Dealers,
Circle (501) on Fast Fact Card

Analyzer adds 3:1 digital capability to iDEN radio equipment testing



The R-2660B communications system analyzer from **Motorola Communication Test Equipment** provides testing for iDEN 3:1 digital subscriber and site radio equipment. The new model's 3:1 capability enhances the iDEN 6:1 test format of the original R-2660A analyzer. For subscriber units, the R-2660 offers dynamic call testing of dispatch and interconnect calls, live voice verification and comprehensive test mode support. For site equipment, the analyzer offers transmitter and receiver testing in test mode and a live site-monitoring capability. To make way for the enhanced model, Motorola is offering a special price on its current stock of the original R-2660A models, as well as the R-601 3:1 conversion kit for upgrading the original unit. Both R-2660 models also provide a selection of general-purpose test capabilities, including a spectrum analyzer with a tracking generator, cable fault testing, oscilloscope and other diagnostics.

Circle (409) on Fast Fact Card

Trunking repeater manager upgrades accommodate more ID numbers

Zetron has released new ESAS (Extended Sub-audible Signaling) software and a companion product, the model 498 Extended Memory Module. The products are designed to upgrade Zetron's model 49 Trunking Repeater Manager and Uniden's MRS804ZX Repeater Package for ESAS operation. The upgrade allows the use of ESAS radios while allowing the existing LTR radios to remain in the communication system without any reprogramming by the operator. The ESAS protocol, developed by Uniden, extends the standard LTR data packet. ESAS provides autoregistration when roaming to a new system, which allows 8,000 ID numbers per site compared to the LTR maximum of 5,000. The memory module is designed to provide validation for the larger number of identification numbers and to record an interconnect call's detailed records for billing software.

Circle (410) on Fast Fact Card

Hardware evaluates CMDA, TDMA 1,850MHz–1,990MHz systems

Hewlett-Packard has introduced a PCS interface for its HP 8921A RF and HP 8924C mobile station test sets. The HP 83236A PCS interface extends the capabiliites of the test sets to evaluate IS-136 PCS 1900 (TDMA) and IS-96 PCS (CDMA) systems operating in the 1,850MHz–1,990MHz band. For base station testing, the interface is controlled through the instrument control bus to automate key procedures, such as mobile-unit, cell-site and interference testing.

Circle (411) on Fast Fact Card

Distribution

VCP International has added NEC replacement parts to its product line, which also includes replacement parts for Motorola, Panasonic and Uniden.

Through a distributing agreement with Motorola, VCP is also now selling Motorola pagers with approved federal government frequencies, formerly only available from the manufacturer.

For more information, contact 800-442-7001

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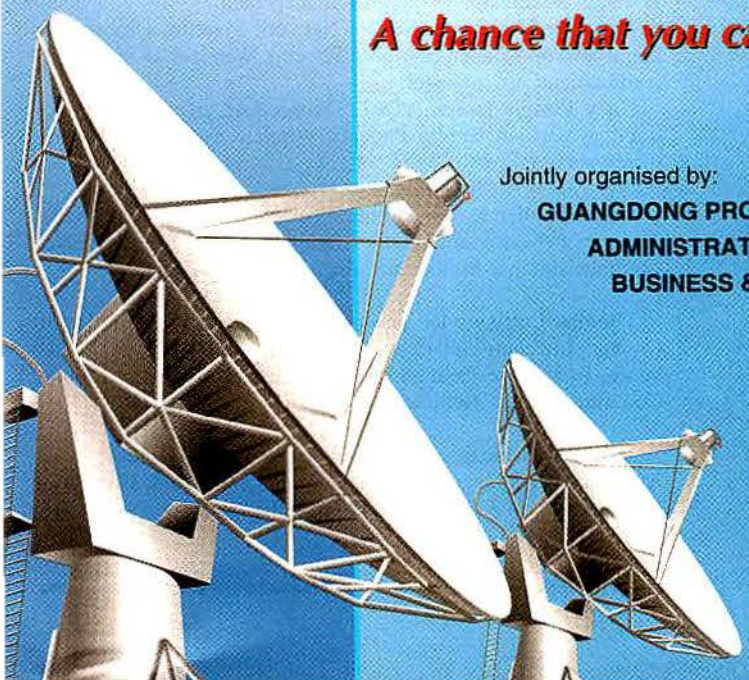

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Circle (71) on Fast Fact Card

People


Bishop


Dyle


Kizaur


Propson

Bruce Bishop, vice president of communications systems for Tecom Industries, Chatsworth, CA, advances to vice president of engineering.

Changes at Cellcom, DePere, WI:

Randy Dyle leaves Hy-Test Safety Shoe Service, Milwaukee, as territory sales manager to join Cellcom as wireless sales consultant for the Green Bay area.

Joseph A. Kizaur leaves Fort Howard's Ecosource Subsidiary, Fort Howard, WI, as plant manager, to join Cellcom as customer service manager.

Keith Propson leaves Schumaker, Romenesko & Associates, Appleton, WI, as staff accountant to join Cellcom as director of accounting and administration.

Rhett Grotzinger leaves Kenwood Systems Group, Houston, as general manager to join Trident Micro Systems, Huntington Beach, CA, as vice president of sales and marketing.

Philip E. Abbate leaves ElectroCom Communication Systems, Santa Fe Springs, CA, as new business development manager to join Dataradio, Atlanta, as territory manager, public safety, for the western United States.

Jerry Kirshman departs Ascor Electronics, Hicksville, NY, as Long Island sales manager to join Loral Microwave-Narda, Hauppauge, NY, as regional sales manager.

Changes at Phoenix Wireless Group, Maitland, FL:

Paul Mueller, vice president of sales and marketing, advances to executive vice president.

David Harlow leaves Comsat RSI, Herndon, VA, as director of product management for wireless systems to join Phoenix Wireless as director of product management.

Lori Luedtke leaves Hughes Network Systems, Chicago, as major accounts manager to join Phoenix Wireless as marketing communications manager.

Gary Fimple leaves AT&T, Dublin, OH, as senior product training manager to join Phoenix Wireless as director of customer service.

John Schaller leaves Northern Telecom, Richardson, TX, as director of finance of Nortel's wireless networks to join AirNet Communications, Melbourne, FL, as vice president.

Thomas Collins, vice president of finance and planning for Comsat International Communications, Bethesda, MD, advances to vice president and general manager of Comsat Mobile Communications, Bethesda.

MobiLink, Chicago, has elected **Jack Rooney**, president of Ameritech Cellular Services, as chairman and **Mark Feighner**, president of GTE Mobilnet, as vice-chairman.

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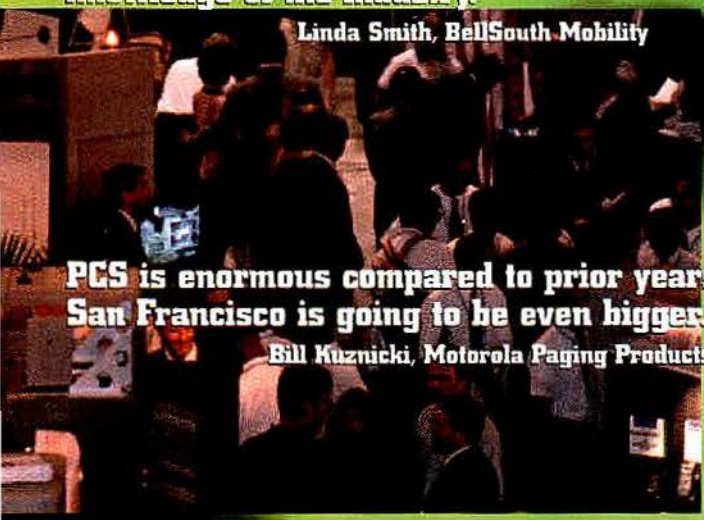
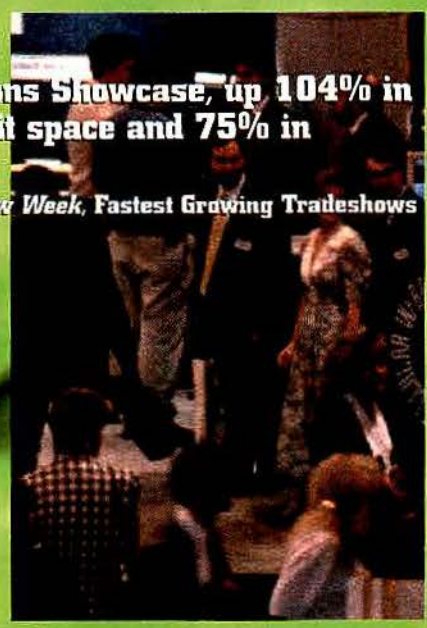
Linda Smith, BellSouth Mobility



PCS is enormous compared to prior years, San Francisco is going to be even bigger.
Bill Kuznicki, Motorola Paging Products Group



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Circle (74) on Fast Fact Card

Literature

Catalog highlights RF Switches

Narda has released a 108-page catalog featuring its complete line of RF and microwave electromechanical switches. New to this catalog are low-cost models, hot-switching models, switches for wireless applications and a matrix section with worksheet. The catalog contains an index to cross reference Narda's standard line with custom units, which may alert a customer to a standard, stocked unit available immediately and at a lower cost.

Circle (450) on Fast Fact Card

Buyers' Guide is 'Your Total Source'

Tessco offers more than 1,000 pages of equipment and supplies for wireless communications in its new buyers' guide. The free guide contains 13,000 products from more than 170 manufacturers and is fully indexed with complete specs and guaranteed pricing.

Circle (451) on Fast Fact Card

Data sheet features field analyzers

A two-page data sheet is available from **Wandel & Goltermann** on its EFA-1 and EFA-2 field analyzers. The analyzers measure magnetic fields from 5Hz to 30kHz. This makes the analyzers well-suited for measuring magnetic field strength to ensure safety in the workplace where electromagnetic radiation is possible.

Circle (452) on Fast Fact Card

Book covers waveforms in adapted wavelet analysis

Adapted Wavelet Analysis from Theory to Software, has been released from **IEEE Press.** The book offers detailed coverage of waveforms used in adapted wavelet analysis.

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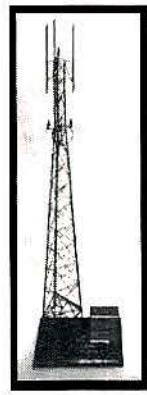

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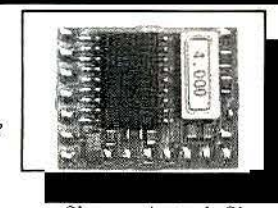

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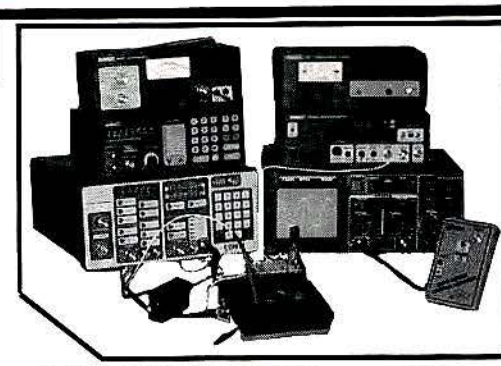

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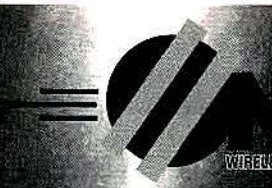

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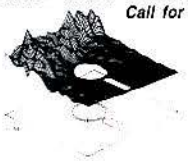

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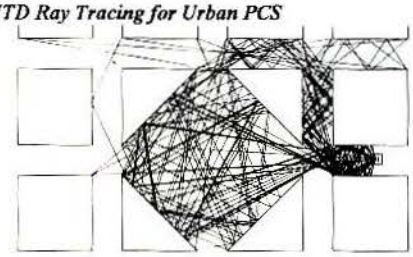

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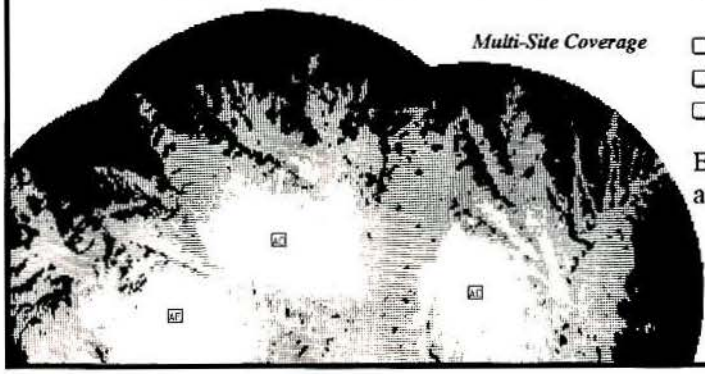

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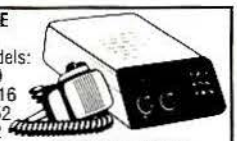

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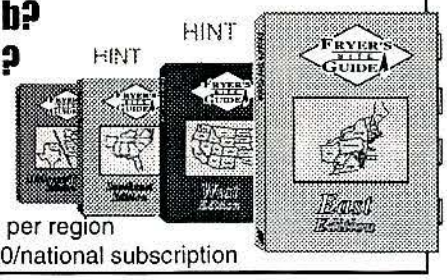

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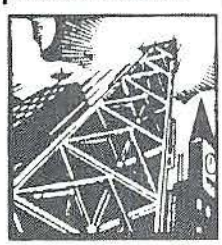

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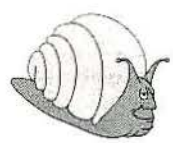

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